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REGIONAL AIR POLLUTION ANALYSIS

TRW Systems Group

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REGIONAL AIR POLLUTION ANALYSIS

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Prepared for

U. S. Department of Health, Education and Welfare
Public Health Service
National Air Pollution Control Administration
Washington, D. C.

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PREFACE

This report, along with a computer program demonstration, culminates the first year's work on a systems approach to regional air pollution analysis by TRW Systems Group.

For the past year, TRW has applied an approach which has been evolving in recent years and has been described by Dr. Simon Ramo, Vice Chairman of the Board, TRW Incorporated, as an

> ...intellectual discipline for mobilizing science and technology to attack complex, large-scale problems in an objective, logical, complete, and thoroughly professional way. Called the Systems Approach, it depends upon use of a team of cooperating experts in both the technological and nontechnological aspects of the problem to be analyzed. Resting in part on the computer to assist in weighing and relating facts and relationships, the systems approach is an extended, a somewhat automated, common sense. It is more especially a reasoned and total, rather than a fragmentary, look at problems, seeking to push confusion and hit-or-miss decision-making into the background and leaning heavily on rational concrete judgments.

The preliminary result of this approach, described in detail in the following report, is a computer program entitled Regional Air Pollution Analysis (RAPA). However, the RAPA program is more than a collection of computer models. It is a team project reflecting the efforts of:

CONSAD Research Corporation

Resources Research Incorporated

TRW Systems Group

and key contributions from:

Al Barnard (RRI)
Alan Bos
William Dickerson
Robert Herrick (RRI)
Diane Latsch
Don Lewis

Fu Chen Lo (CONSAD)
Ken McAlhany
Larry Rothman
Art Silvers (CONSAD)
Tom Smith
Keiji Tasaki
Sandra Ugel
Troy Williams
Linda Wilson
Tom Wright (RRI)

A significant input to the RAPA project, aside from published documents, came directly from the members of the National Air Pollution Control Administration. In addition to the constant guidance from Robert Jimeson, the program is indebted to the earlier mathematical-modeling contributions of DeLance Martin and Joe Tikvart for their atmospheric diffusion model, the statistical studies of pollutant concentration by Ralph Larsen, and many others at NAPCA who have established the present state-of-the-art in the field of air pollution control analyses.

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1. PROJECT SUMMARY

In July, 1968, the National Air Pollution Control Administration (NAPCA) contracted TRW Systems Group to initiate a system analysis for regional air pollution control. The aim was to integrate contemporary air pollution control developments into a workable analytical computer program which could incorporate improvements with ease. The latter factor was important because fundamental research continually achieves more explicit definitions in such areas as atmospheric diffusion of pollutants or more quantitative expressions of air pollution damage. During the first year, TRW developed a program--Regional Air Pollution Analysis (RAPA)--and demonstrated it, using data for the city of St. Louis.

The RAPA program is a modular integration of mathematical models based on presently available scientific and engineering data. It is illustrated in Figure 1-1. In developing phase I of RAPA, TRW Systems was guided by:

(a) The intentions of the Air Quality Act of 1967.

(b) The final publications of SO_x and particulate criteria documents, and the SO_x and particulate control technique documents.

(c) Existing computer programs and mathematical models, such as the atmospheric diffusion of pollutants and the statistical representation of pollutant concentrations at various averaging times.

(d) The advice of key NAPCA personnel.

In addition the RAPA program design has been fashioned to suit several guidelines set forth by NAPCA, including:

(a) A provision to display existing regional air quality levels for later comparison with those levels resulting from the implementation plans. This comparison insures

ATMOSPHERIC TRANSPORT

- SO_X, PARTICULATES, CO
- SUMMER, WINTER,ANNUAL
- 200 POINT, AREA, LINE SOURCES
- 237 RECEPTORS
- 16 WIND DIRECTIONS, 6 WIND SPEED CLASSES, 5 STABILITY CLASSES
- LEAST-SQUARES REGRESSION ON 20 MEASURING SITES
- 5 SELECTED AVERAGING TIMES
- 3 SELECTED PERCENTILE CONCENTRATIONS

CONTROL COST-EFFECTIVENESS

- AIR POLLUTION CONTROL DEVICES
- NON-DEVICE AIR POLLUTION CONTROL MEASURES
- MANUFACTURERS' PRICE
- OPERATION AND MAINTENANCE COSTS
- CAPITAL COSTS
- CONTROL EFFICIENCIES

ABATEMENT STRATEGY

- MAXIMUM CONTROL TECHNOLOGY
- DIFFERENTIAL CONTROLS
- FUEL SULFUR CONTENT LIMITATIONS
- FUEL SUBSTITUTION
- SOURCE EMISSION STANDARDS
  - DISCHARGE CONCENTRATION LIMITATION
  - PROCESS WEIGHT RESTRICTIONS
  - COMBUSTION RESTRICTION

REGIONAL ECONOMETRICS

- TWO-DIGIT SIC CODES
- EMPLOYMENT BY INDUSTRY
- UNEMPLOYMENT BY REGION
- INDUSTRIAL CONTROL INVESTMENTS PER VALUE ADDED
- REGIONAL TAX RECEIPTS
- GROSS REGIONAL PRODUCT
- INVESTMENT AND CAPITAL STOCK CHARGES

Figure 1-1. Regional Air Pollution Analysis Program

that no conflicts arise with the purpose of the Act; "...to protect and enhance the quality of the nation's air resources." In addition, the comparison will portray air quality conditions that may arise in meeting the air quality standards of interstate Air Quality Control Regions.

(b) A means of evaluating the effectiveness of implementation plans in achieving minimum air quality standards based on a concern for public health, and more stringent air quality standards in areas where higher levels of air quality are desired.

(c) A means of charting progress towards achieving air quality standards through implementation plans which considered the time-varying factors of available control techniques, normal shifts in the industrial and demographic features of a region, technological advances in reducing the root causes of air pollution, and so on. This provision is by no means automatic; it requires manual changes to the program's emission inventory and additions to a growing catalog of air pollution control-measure capabilities.

(d) A variety of output material (air quality contour maps, cost function graphs, air pollution statistics, etc.), to assist in describing air quality standards and implementation plans at State public hearings and for submission of plans to the Federal government. This material also will provide a more uniform means of evaluating the standards and implementation plans as to their consideration of concentration-exposure time-effect relationships, criteria documents, and economically and technologically feasible methods of controlling pollutant emission provided in the control techniques documents.

The RAPA program is a versatile tool, satisfying several uses. One of its major uses is the processing of a myriad of air pollution data. Such data includes meteorological factors which influence pollutant motion, sources and processes of pollutant generation, the cost of air pollution control measures, regional economic activity, and other pertinent data. The processing of this information permits RAPA's user to determine which air pollution control approaches might best achieve the regional goals in air quality standards.

The program has been demonstrated using St. Louis data and a selected set of air pollution abatement strategies. The conclusions drawn from the St. Louis demonstration are presented in the Appendix, but they should not be construed as solutions to specific St. Louis air pollution control planning. The St. Louis region was selected to provide representative data with which to exercise the RAPA program; however, the limitations of the demonstration in terms of data availability and model calibration precluded an extensive analysis for that region.

The RAPA program contains several analytical functions with the features illustrated in Figure 1-1. These can be used in a variety of ways, depending on the specific aspect of the air pollution problem under study. The uses of the program range from simply displaying estimates of existing air quality conditions, to calculating the costs of air pollution reduction and effectiveness of control devices and, finally, to computing estimates of economic and air quality impacts resulting from the application of air pollution control strategies. Figure 1-2 helps to visualize the general way in which the RAPA program deals with these issues and, more importantly, the extent of manual interactions with the computer program.

Generally, and in the St. Louis example, the RAPA process begins with the user specifying a goal reflecting the desired air quality for a region. This goal may be stated in terms of long-term (e.g., annual) average pollutant concentrations or short-term (e.g., 24 hour) peak pollutant concentrations. The computer program accepts the air quality standard along with the region's existing emission inventory and meteorological conditions and computes the diffusion of pollutants throughout the region. The result of this computation is a determination of the existing air quality throughout

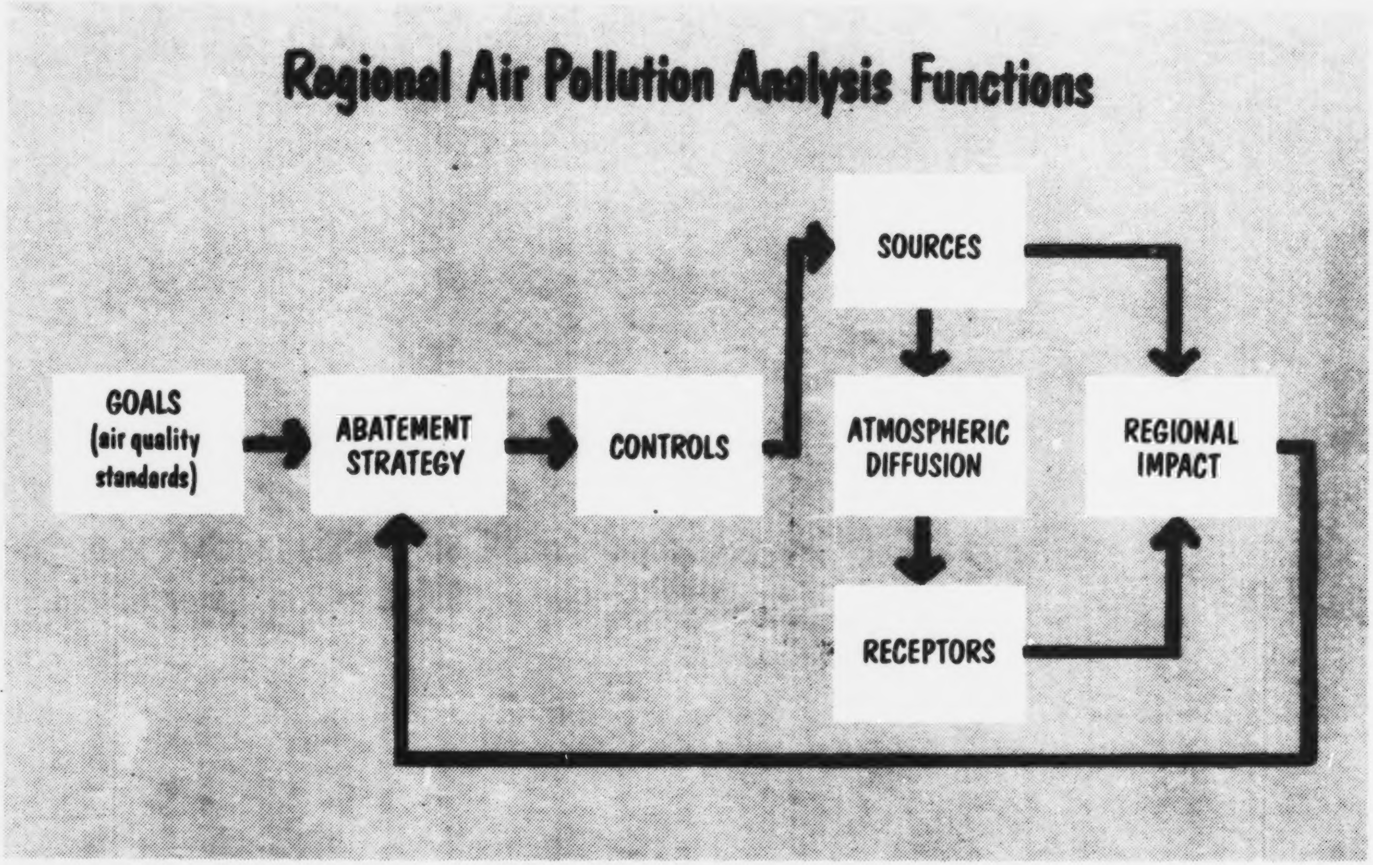

Regional Air Pollution Analysis Functions
GOALS (air quality standards)
ABATEMENT STRATEGY
CONTROLS
SOURCES
ATMOSPHERIC DIFFUSION
RECEPTORS
REGIONAL IMPACT

FIGURE 1-2 Regional Air Pollution Analysis Process

the region in long-term averages and expected peak concentrations for any desired averaging time. In addition, the program provides a list of those receptors at which the desired air quality standard is exceeded, and the pollutant contributions to specific receptor locations from each of the point and area sources within the region.

The user then selects a method of controlling or preventing pollutant emissions with an abatement strategy. He bases his selection on air quality goals, the characteristics of air pollution sources, existing air quality conditions generated by the diffusion process, and many other factors. An abatement strategy is a requirement, imposed on pollutant emitters, which is designed to reduce or prevent pollutant emissions. One strategy can take the form of a process weight regulation where each industrial process is restricted to a pollutant output as a function of raw materials used in its production process. Another strategy may be directed at combustion sources of pollutants where the pollutants are restricted as a function of heat input. In both of these examples the expected response from the various sources at which the strategies are aimed will be to adopt some air pollution control devices (e.g., electrostatic precipitator) or non-device control measures (e.g., fuel substitution) to meet requirements stated in the strategy. For example, inherent in a fuel substitution strategy is the selection of a control measure limiting all users in a region to a specific quality of fuel (e.g., 1% sulfur content).

Thus, the user determines which abatement strategy to process and provides the computer program with the strategy identification as well as with any restriction of sources which must respond to the strategy.

The RAPA program next calculates the control cost and control efficiency (in terms of emission reduction) of each control device or non-device control measure applicable to each pollutant source in the region or to each source specified by the user. The computer program then calculates the emission reduction required at each pollutant source, depending on the abatement strategy. The program then selects the least expensive control device or non-device control measure with the necessary efficiency to meet or exceed that required by the abatement strategy. The choice of control measure will alter the source emission rates which in turn will alter the input conditions to the diffusion process. The computer program recalculates the diffusion equation and provides the user with the revised air quality conditions at each receptor based on the selected abatement strategy.

At this point the user can compute the estimated effect on the regional economy of investments and operating expenses for the control measures required by the abatement strategy. The combined results of control cost expenditures, influences on the regional economy, and air quality conditions form the estimated regional impact of an abatement strategy.

The user is expected to analyze this combined regional impact. If regional air quality standards or any other goals have not been met, he must either choose another abatement strategy or modify the previously selected strategy (e.g., provide more stringent limitation on fuel sulfur content). Providing the program with another or modified abatement strategy will constitute a re-run of the above procedure as indicated by the feedback path in Figure 1-2.

The RAPA process just described covers the present status of the Phase I program.

The next phase of activities on the Regional Air Pollution Analysis program will include:

(a) Converting the Regional Air Pollution Analysis program, developed as a Phase I demonstration, into an operational program on the Department of Health, Education and Welfare's computer.

(b) Performing extensive experiments to test the sensitivity of input data and to validate the RAPA Phase I program.

(c) Modifying the various models of the RAPA Phase I program, including the addition of a Damage Function Model, to achieve an expanded and more comprehensive RAPA program.

(d) Testing regional and national air pollution control strategies with single or aggregated RAPA results to provide estimates of the national impact of air pollution control.

(e) Relating the RAPA program to other models being designed in the area of air pollution control, such as the Fossil Fuel Availability Model. This model is expected to provide RAPA with additional refinements in the costs and availability of alternative fuels in fuel-substitution or switching strategies.

A severe shortcoming in the use of computer programs of this nature is the degree of credibility attributable to the results simply because they are printed by a machine. The designers of the computer models in the RAPA program are very much aware of the fact that the model outputs are a direct function of input information and, more importantly, that the models are incapable of judging the accuracy of this information. Therefore, although the results seem to be "official", they may be based on incorrect input information. Any use of the RAPA program for air pollution control planning must be tempered with a thorough knowledge of the program's information requirements. Much of next year's activities will be directed at defining both the sensitivity requirements and the program's true capabilities.

2. REGIONAL AIR POLLUTION ANALYSIS MODELS

2.1 INTRODUCTION

The Regional Air Pollution Analysis program (RAPA) is intended as an analytical tool for use in assessing levels of air pollution in metropolitan areas, and in analyzing air pollution abatement strategies designed to meet regional air quality goals.

The Air Quality Act of 1967 requires the Federal government to set up regional boundaries for concerted efforts in controlling air pollution. These regional boundaries define the system boundaries for the RAPA program. Scientific, economic and engineering information on the effect of air pollution and alternative measures for its control also provide important source data for the RAPA program.

Information on the effects of air pollution is reported in terms of air pollutant criteria. These criteria are a compendium of today's scientific findings on the adverse effects of specific air pollutants and combinations of pollutants on man and his environment. The evidence in criteria documents regarding human health, animal health, plant damage, material damage, and visibility are not necessarily the lowest levels of exposure below which there are no adverse effects; however, they do provide quantitative guidance to the States for setting regional air quality standards.

Air quality standards developed with the guidance of these air quality criteria are goals established for the protection of public health and welfare. They provide the States with a basis for controlling existing sources of pollution emission and preventing future regional growth from adding to the pollution problem. Regional goals may reflect more than one air quality standard, insuring minimum air quality levels as well as higher levels of air quality. These goals must preclude any significant deterioration of existing high air quality levels.

Engineering and economic information on control of air pollution is reported by the Federal government. Handbooks are issued on available control devices, such as filters and precipitators, and non-device control measures, such as the use of low sulfur content fuels or alterations to basic industrial processes which lessen pollution.

Within a specified time period, the State government must set air quality standards which reflect regional goals for clean air. Having set these standards, the State is responsible to establish implementation plans. These plans may set forth regulatory procedures, such as pollutant source emission standards, to achieve air quality standards. The limitation of pollutant emissions through source emission standards, along with other regulatory procedures such as zoning regulations or fuel restrictions, forms an abatement strategy designed to achieve regional air quality within a reasonable time period.

Estimating the consequences of timely abatement strategies requires extensive examination of the following factors involved in the air pollution system: meteorology, air pollution control technology, air pollution growth trends, source emission inventories, existing regional air quality conditions, and regional economic impact. The RAPA program is a self-contained planning tool, consisting of several models which consider all of the above factors in assessing the total impact of selected abatement strategies.

The RAPA program accomplishes its work as an analysis tool (Figure 2-1) with:

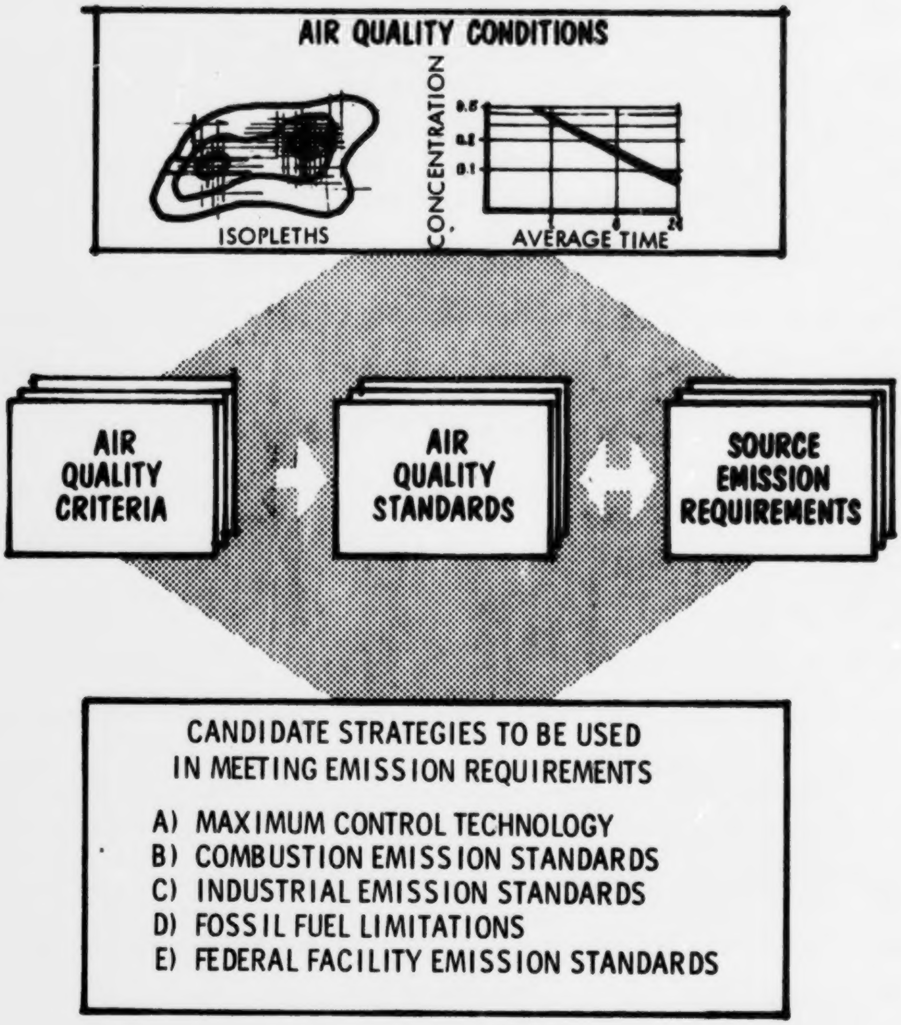

AIR QUALITY CONDITIONS
ISOPLETHS
CONCENTRATION
0.5
0.2
0.1
AVERAGE TIME
24
AIR QUALITY CRITERIA
AIR QUALITY STANDARDS
SOURCE EMISSION REQUIREMENTS
CANDIDATE STRATEGIES TO BE USED IN MEETING EMISSION REQUIREMENTS
A) MAXIMUM CONTROL TECHNOLOGY
B) COMBUSTION EMISSION STANDARDS
C) INDUSTRIAL EMISSION STANDARDS
D) FOSSIL FUEL LIMITATIONS
E) FEDERAL FACILITY EMISSION STANDARDS

FIGURE 2-1. Regional Analysis Process

(a) A display of calculated existing and projected regional air quality based on emission inventories and meteorological conditions.

(b) Comparisons with air quality criteria and standards.

(c) Determination of the quantitative level of pollutant emission which will meet air quality standards, and, finally,

(d) Estimates of costs and air quality levels resulting from selected abatement strategies.

2.2 ATMOSPHERIC DIFFUSION OF POLLUTANTS

The first step in calculating existing or projected ground-level air quality conditions is to compute the movement of pollutants using an Atmospheric Diffusion Model. The atmospheric diffusion of pollutants from any given source takes place under the processes of advection due to net air motion, and diffusion due to random atmospheric turbulence. The pollutant plume moves away from the source in a downwind direction as a result of advection and diffusion, and expands laterally as a result of diffusion. Under these conditions, the Atmospheric Diffusion Model shows each source's contribution to ground-level pollution concentration throughout the region by providing mathematical transfer functions between individual source emission and regional measures of air quality. The transfer functions are also used to determine the effects of various source emission control and overall abatement strategies on regional air quality.

A combination of two modeling techniques is used to allow the Atmospheric Diffusion Model to determine the influence of each source at each receptor point on a seasonal basis and on short averaging time periods. A Gaussian diffusion equation transforms source emission data into average ground-level, long-term pollutant concentrations; and a set of statistical relationships determines the expected maximum for ground-level concentrations at different averaging times. The diffusion model alone cannot be used to develop ground-level concentrations for various averaging times, since the upper end of the concentration versus averaging time distribution (i.e., those concentrations exceeded, say one percent of the time, or the expected annual maximum) occurs under short-term meteorological conditions. Calculation of these short-term results would require a model conceptually different from the diffusion model currently in use.

The diffusion equations compute an arithmetic seasonal average of ground-level concentration resulting from specified area and point source emissions. At each receptor location the model sums the effects of all sources over a complete range of meteorological conditions. Within a single run the model provides the ground-level concentration of the three pollutants: sulfur dioxide, carbon monoxide, and particulates, in three time periods: summer, winter and annual.

An added automatic program feature in the operation of the diffusion model is the "correlation" data. This is simply a method of setting the model to have the computed theoretical ground-level concentration adjusted by a comparison with available measured ground-level concentrations. Values of least-square regression lines of measured concentrations are used to check and correct calculated concentrations of each pollutant/season combination at each selected air quality measuring point throughout the region.

The output of the diffusion model (Figure 2-2 (a)) includes punched cards for contour plots (isopleth) of long-term arithmetic average ground-level concentrations, punched cards for SYMAP plots (discussed in detail in Chapter 4) and a tabular list of the arithmetic average ground-level concentration at each receptor.

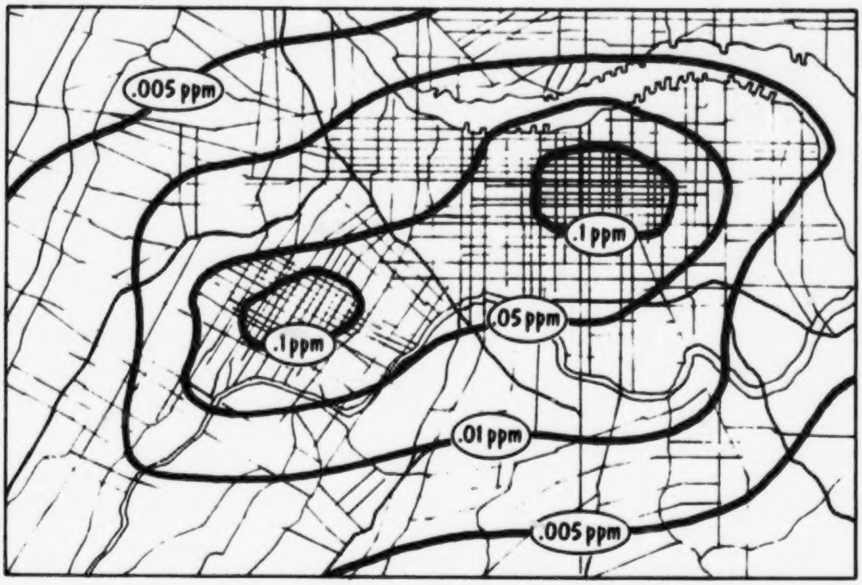

.005 ppm
.1 ppm
.05 ppm
.1 ppm
.01 ppm
.005 ppm

FIGURE 2-2(a) Isopleth Map

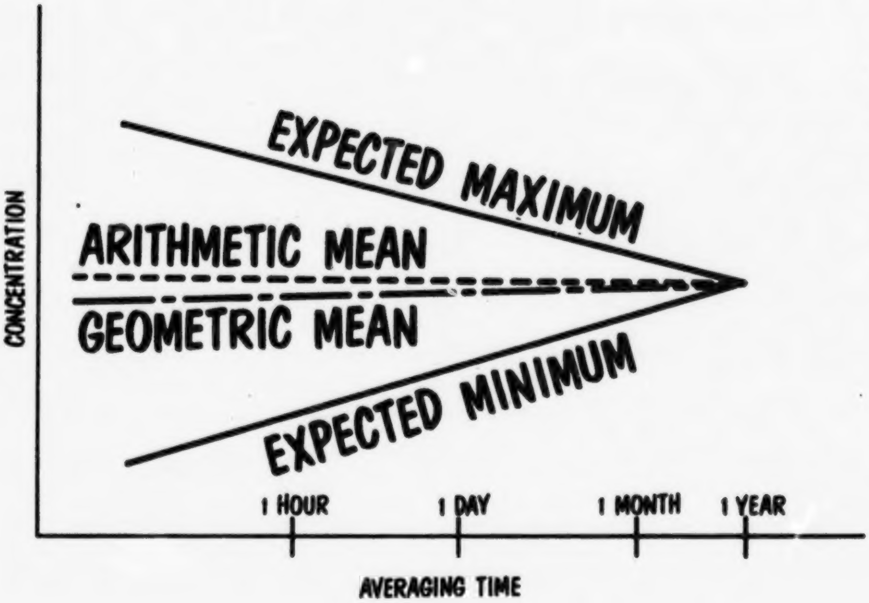


FIGURE 2-2(b) Statistical Relationships

The diffusion model used in the RAPA program is a modified version of NAPCA's Martin-Tikvart model. The modifications include both major programming changes to increase operating efficiency and minor theoretical changes resulting from discussions with NAPCA meteorologists. The major changes to the original program include:

(a) Re-structuring of program operations to decrease computer execution time. This effort resulted in an execution-time reduction of approximately 25%.

(b) An added capability to consider, within a single run, any or all pollutant-time period combinations of the three pollutants, SO_x, CO and particulates, and the three time periods, summer, winter, and annual.

(c) Changed output receptor pattern from radical to rectangular. As noted by Delance Martin of NAPCA, the rectangular pattern has the advantage of producing a uniform picture of air quality for the entire region under consideration. In addition to the rectangular grid pattern, allowance was made for user selected receptor locations.

(d) An added capability for source location input in units of degrees latitude and longitude, kilofeet or kilometers.

(e) Addition of the Holland plume-rise equation to calculate effective stack height from input stack parameters.

(f) Addition of a residence decay-factor for SO_x.

(g) Removal of the "wind direction factor." This factor was used to account for the limited time with which the wind blows from a given direction. As described by Ken Caldev, NAPCA, this term is not generally applicable.

The assumption that ground-level pollutant concentrations are lognormally distributed for all pollutants and all averaging times provides the program with several statistical relationships. These statistical relationships, along with the annual arithmetic mean concentration computed by the diffusion model, allow the user to estimate the expected maximum and geometric-mean pollutant concentration at various averaging times.

Figure 2-2(b) illustrates the process undertaken by the program and the user in calculating both the expected maximum and geometric-mean concentration functions for all averaging times.

Starting with the output of the diffusion model, the annual arithmetic-mean concentration for a particular pollutant, the program computes the annual geometric-mean and annual expected maximum concentration. Both of these calculations depend on a known value of the geometric standard deviation for a given averaging time. Regardless of which averaging time is used for the geometric standard deviation, a relationship exists for converting the known value of a geometric standard deviation to any other averaging time.

The program computes the expected maximum concentration for the average annual period and, through similar computations, for any selected averaging period. Under the basic assumption that the expected maximum concentration is inversely proportional to the averaging time to an exponent (i.e., a straight line or a logarithmic plot), only two points need to be defined to arrive at the expected maximum concentration for all averaging times. The statistical relationships in the program permit the conversion of the geometric standard deviation to any other averaging time, as well as the computation of a geometric mean and, finally, an expected maximum value for the other averaging time. Now with a second expected maximum value and a second geometric mean value, two straight lines can be defined as the logarithmic plot of concentration versus averaging time.

The user can now read off the expected maximum and geometric mean concentrations for all averaging times.

2.3 CONTROL COST-EFFECTIVENESS

The computation of control cost and emission reduction effectiveness values provides an indication of the least-cost control measure which will satisfy required source emission values on a source-by-source basis. The direct costs of these control measures, when summed over their application to air pollution sources, provide estimates of regional control costs. The total regional cost and other economic variables, are used as inputs to a regional econometric model to measure the economic impacts of investments and operating expenses in air pollution control.

Each air pollution source, such as an industrial plant, power-generating station, or apartment house, has one or more control-measure options for reducing its pollutant emissions. Furthermore, each control measure has different costs and control efficiencies, depending on the source to which it is applied. The Control Cost-Effectiveness Model, supplemented by the data files, searches out and selects the applicable source-control measure and itemizes cost-effectiveness information for each specific source or source category in the region.

Figure 2-3 illustrates three possible control devices applicable to the control of particulates from a specific-size asphalt batching plant. The costs shown for the asphalt plant represent total annual costs, including major items such as manufacturer's price, installation costs, annual capital charge, and operation and maintenance costs. In computing these major expenses, the model takes into account equipment depreciation,

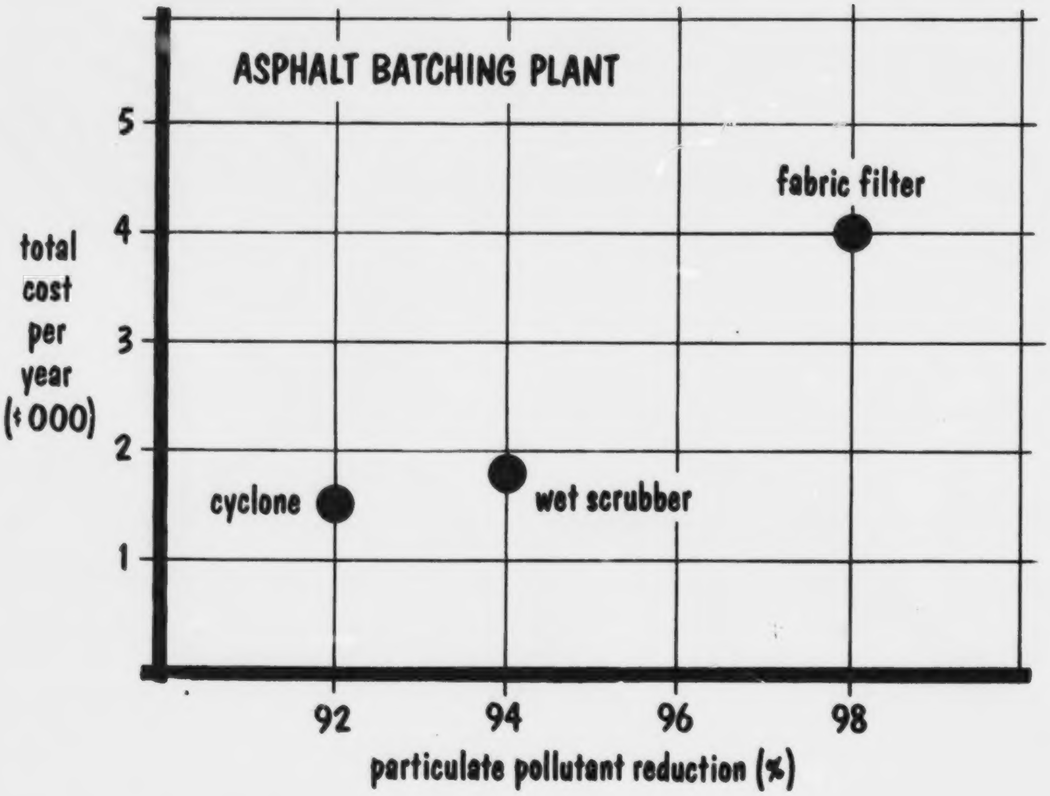


FIGURE 2-3. Control Cost-Effectiveness of Various Control Devices and Specific Size Plant.

schedules, interest rates on capital, cost or credit of disposing pollutants, and so forth. The model also considers the variations in costs from region to region in accounting for equipment transportation costs, service utility connections, labor costs, etc.

Each possible output of the Control Cost-Effectiveness Model is an answer to one of several user options. The outputs can be grouped to display the set of alternative control measures available to any single air pollution emission source, along with estimates of the annual cost and efficiency of each control measure. By further aggregation of the results, a similar display can be constructed for groups of sources, as for instance two-digit Standard Industrial Classification Codes or all combustion sources. Other options include displays of control measures with lists of applicable sources and their associated costs and efficiencies. Finally, the user has the option of printing the complete data file containing all information supplied to the model regarding control cost and efficiency.

2.4 ABATEMENT STRATEGIES

Air quality regions will develop implementation plans designed to achieve and maintain air quality standards. The heart of these implementation plans is the abatement strategy, which prevents or controls air pollution source emissions within a specified timetable. Abatement strategies are defined as preventive or controlling schemes directed at segments of the pollution sources (e.g., combustion sources, industrial sources, Federal facilities) or as selected types of regulations, including source emission standards or some regulations pertaining to fuel use, rules for the location of new industrial plants and other sources of air pollution, restrictions on open burning, plans for disposal of solid wastes, and so on.

In the context of the RAPA program, an abatement strategy is considered to be an overall plan which specifies the types of air pollution sources to be controlled and how they are to be controlled, in order to reduce the chronic, long-term air pollution problem. There is significant interaction between control of long-term and short-term air pollution problems. Reduction in average long-term, ground-level concentration results in a correspondingly reduced frequency of episode conditions. The Abatement Strategy Model, in conjunction with the statistical relationships in the Atmospheric Diffusion Model, allows the user to observe the effect of a strategy on both chronic and acute regional air pollution problems.

Specifically the present RAPA program design includes: a strategy whereby air pollution sources adopt maximum control technology without regard to economic factors; a strategy of optimal control whereby the emissions of each air pollution source are reduced on the basis of an air quality standard, the cost of a unit reduction in emission, and the magnitude of the pollutant emission; a strategy to limit the use of certain fuel types; and finally, a strategy whereby all air pollution sources are asked to adhere to a specific source emission standard.

The Abatement Strategy Model provides a reasonably accurate and quantitative procedure for simulating the impact of various control strategies in a computer-processed mathematical model. This model allows the RAPA program to be used as a "gaming" tool. The user can specify an air quality standard and an abatement strategy and observe the resulting change in regional air quality and the cost of this change. On the basis of the results, he can modify the specifications for another "run".

The model postulates the type of control measures which would be used to make an air pollution source meet the proposed source emission requirements. Inherent in the model is the assumption that those responsible for air pollution sources will use the control techniques resulting in the least cost to the source facility. A simulation of a strategy applying assumed least-cost control measures to the sources of pollution assists the user in evaluating implementation plans with reasonable ground-level pollutant concentrations and direct control costs. The Abatement Strategy Model provides sufficient information to evaluate the regional impact of selected strategies in terms of: (a) the types of sources affected by the strategy; (b) the degree to which these sources are affected in terms of control costs; (c) the resulting change in pollutant emissions; and (d) regionally aggregated values of control costs by source category, total reduction in pollution emissions, changes to regional fuel-use patterns, and resulting air quality levels.

2.5 REGIONAL ECONOMIC IMPACT

In addition to the estimates of direct costs of air pollution control measures resulting from an abatement strategy, there are indirect economic effects such as gross regional product, industrial expenditures on controls per value added, etc., which occur in a region as a result of the application of controls. One way to estimate these indirect economic effects is through the application of an econometric model. Generally, a regional econometric model shows the magnitude of the economic impact of air pollution control investments. The RAPA econometric model provides a means for assessing the off-setting economic benefits which may accrue to industries producing air pollution control equipment, as well as any liabilities to industries investing in air pollution control measures.

In deciding upon production plans, industries traditionally have not had to consider the external costs generated by their activities. Were they required to do so, they would notice the costs of production to be increased, perhaps to a prohibitive degree. In particular, industries emitting harmful pollutants into the air during the production process have, by not bearing the cost of the resulting social damage, enjoyed the advantages of lower costs of production. With additional concern for air quality, industries will be encouraged to control the amount of pollutants that they discharge into the air. To the industry, this means that output production costs will be increased in proportion to the required investments in air pollution control equipment. Thus, certain economic sectors that have in the past enjoyed the economic advantage of low-cost production at the expense of polluting the environment may face some degree of economic decline due to the costs of pollution abatement strategies.

The Regional Econometric Model is designed to operate as an independent or integrated model within the RAPA program control. The model provides a public policy analysis, including the effects of pollution control investments resulting from enforcing abatement strategies. This includes economic expansion expected from reduced air pollution damage, and the growth of pollution control equipment manufacturing. Other factors considered are: regional industrial output, fiscal tax base, the rate of achieving an implementation plan as a result of tax credits, and statistical indicators including industry-specific ratios of control costs to total investment and value added in production.

Figure 2-4 illustrates the input data and output estimates of the Regional Econometric Model.

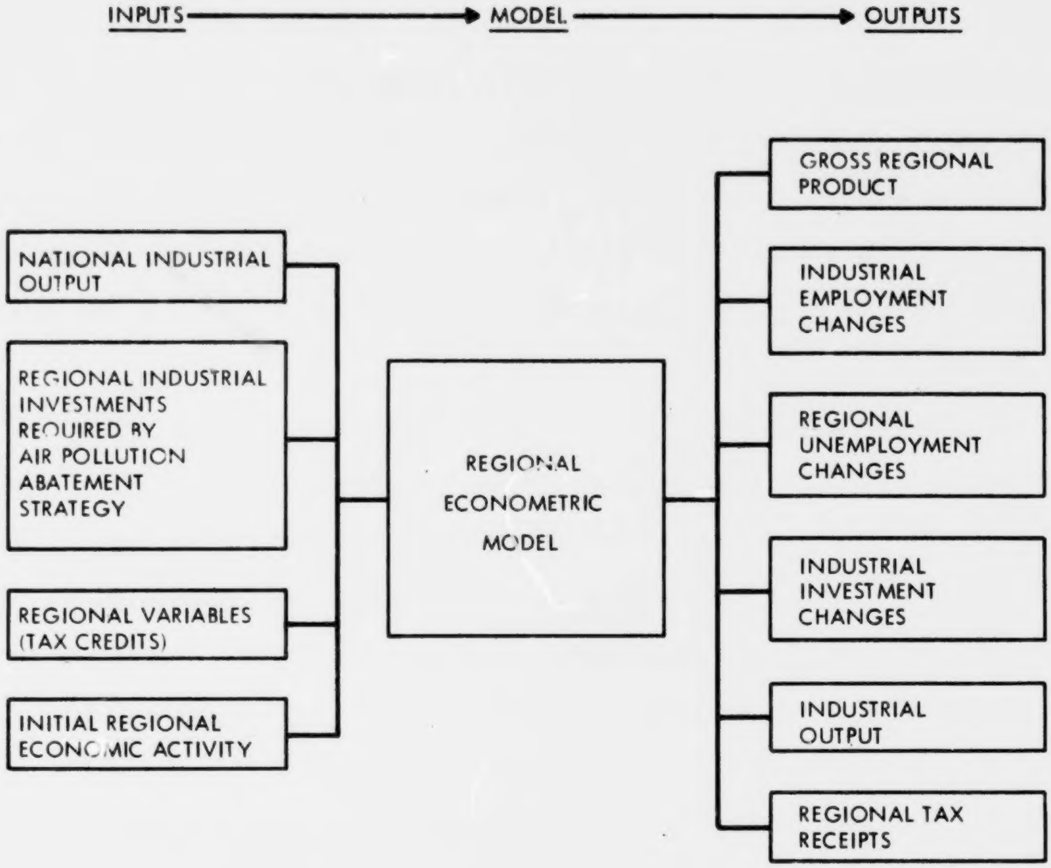

INPUTS
MODEL
OUTPUTS
NATIONAL INDUSTRIAL OUTPUT
REGIONAL INDUSTRIAL INVESTMENTS REQUIRED BY AIR POLLUTION ABATEMENT STRATEGY
REGIONAL VARIABLES (TAX CREDITS)
INITIAL REGIONAL ECONOMIC ACTIVITY
REGIONAL ECONOMETRIC MODEL
GROSS REGIONAL PRODUCT
INDUSTRIAL EMPLOYMENT CHANGES
REGIONAL UNEMPLOYMENT CHANGES
INDUSTRIAL INVESTMENT CHANGES
INDUSTRIAL OUTPUT
REGIONAL TAX RECEIPTS

FIGURE 2-4. Regional Economic Impact

The economic estimates provided by the Regional Econometric Model are sensitive to a variety of air pollution control strategies, including those currently available as well as future strategies under consideration.

One factor in determining the rate of implementation of air quality standards will be the estimated rate at which industry can absorb the cost of air quality control equipment installations. The Regional Econometric Model is designed to provide estimates of such rates for thirteen industrial sectors. In this manner, the model may provide data for facilitating the current process of implementation planning.

The future process of implementation planning may be enhanced by providing States and regional agencies with additional strategies for achieving an implementation plan.

The Regional Econometric Model contains over 100 econometric equations which have been calibrated specifically for the seven-county St. Louis metropolitan region, using time-series data over the period 1954-1966.

The model contains 14 economic sectors comprised of 13 manufacturing sectors and one service sector. The 13 manufacturing sectors are of three types: high air pollution emission sectors serving the national markets, high air pollution emission sectors serving the local market, and a non-air pollution emission sector. The high emission sectors are at the two-digit, Standard Industrial Classification, SIC, code level and embrace the specific industries identified in the St. Louis emission source inventory. Sectoring at the two-digit level is dictated by the current availability of time series data, which does not at this time admit sectoring at the four digit SIC level. Where the investment behavior of the specific emission industry follows the pattern of the broader two-digit sector of which it is a part, the level of detail presently achieved in the model adequately represents reality.

2.6 EXECUTIVE CONTROL AND DATA FILE

The separate models discussed in the previous sections are combined in a comprehensive RAPA tool through an executive routine and through a common dependence on the air pollution data file.

The executive routine provides the user with a simple control-card input, preceeding the program cards, which will select any one of four operating modes. The choice in operating modes will include: (a) an independent execution of the Atmospheric Diffusion Model to portray air quality conditions via contour maps or statistical tables, (b) an independent execution of the Control Cost-Effectiveness Model to calculate graphical outputs of cost-effectiveness data for selected source emission, (c) an independent execution of the Regional Econometric Model to determine economic imports, and (d) a completely integrated mode whereby the user tests a specific abatement strategy through the Abatement Strategy Model. In the integrated mode the executive routine calls for the execution of the Atmospheric Diffusion Model, the Control Cost-Effectiveness Model, and the Regional Econometric Model.

The executive routine interprets the control card input, which selects one of the three operating modes, and provides each of the models with the data required for their calculations.

The data in the RAPA files is organized to facilitate the use of computational models. This has reduced the need for special extraction routines for each of the computational models.

Of the four major models, only the Atmospheric Diffusion Model and Control Cost-Effectiveness Model have direct need for the data file. The

Abatement Strategy Model and Regional Econometric Model rely on data already loaded into the computer from the files by the previous models or their computed output.

The files for disk storage have been structured so that only those fields or elements related to a particular task reside within a file. A model desiring input data may call in several files from disks; it will receive only the data it needs -- no more.

3. EXECUTIVE AND INFORMATION MANAGEMENT ROUTINES

3.1 PURPOSE

The Executive and Information Management routines within the RAPA program have the capability of both controlling the major decision modes of the program and providing the various analytical models contained in the RAPA program with an information base upon which to perform their calculations. In addition, the system provides a communications interface between the separate models and between the user and the program.

To accomplish this purpose, the Information Management Routine consists of:

(a) A file maintenance routine to add to or modify the existing data base;

(b) A file pre-edit routine to list updated information and to create an updated file;

(c) An output report routine to provide the user with the results of the program.

The Executive Routine is a master-control program. Its purpose is to sequence the execution of the individual RAPA program and to provide for the proper transfer of data.

3.2 DESIGN SUMMARY

3.2.1 Executive Routine

The RAPA program is built around an executive routine, which controls the sequence of execution of the program models according to the user's choice of operating modes. The four models under control are:

(a) Atmospheric Diffusion Model

(b) Control Cost-Effectiveness Model

(c) Abatement Strategy Model

(d) Regional Econometric Model.

The computer system configuration, as well as the programs under control of the Executive Routine, are shown in Figure 3-1. During the operation of the RAPA program, the IBM 360 Operation System, the Executive Routine, and a computer memory storage area for data common to all the models will reside in the computer. The remaining models and the data files will be provided on demand to the system by the Executive Routine.

There are several options that may be exercised in using the RAPA program. The user may operate the program in the following modes:

(a) Independent execution of the Atmospheric Diffusion Model.

(b) Independent execution of the Control Cost-Effectiveness Model

(c) Independent execution of the Regional Econometric Model

(d) Execution of the Abatement Strategy Model which automatically executes (a), (b), and (c).

A punched control-card input is used to select the operating mode at the beginning of a program execution. Several punched control cards will be assembled into a user control deck which will convey to the Executive Routine the program mode of operation, and to the output routines the user output option.

Figure 3-2 shows the program flow when the system is operated in the integrated mode, where all three computational models are executed. The mode of operation will be determined by the Executive Routine, and the proper model will be run in the correct sequence. Upon completion of

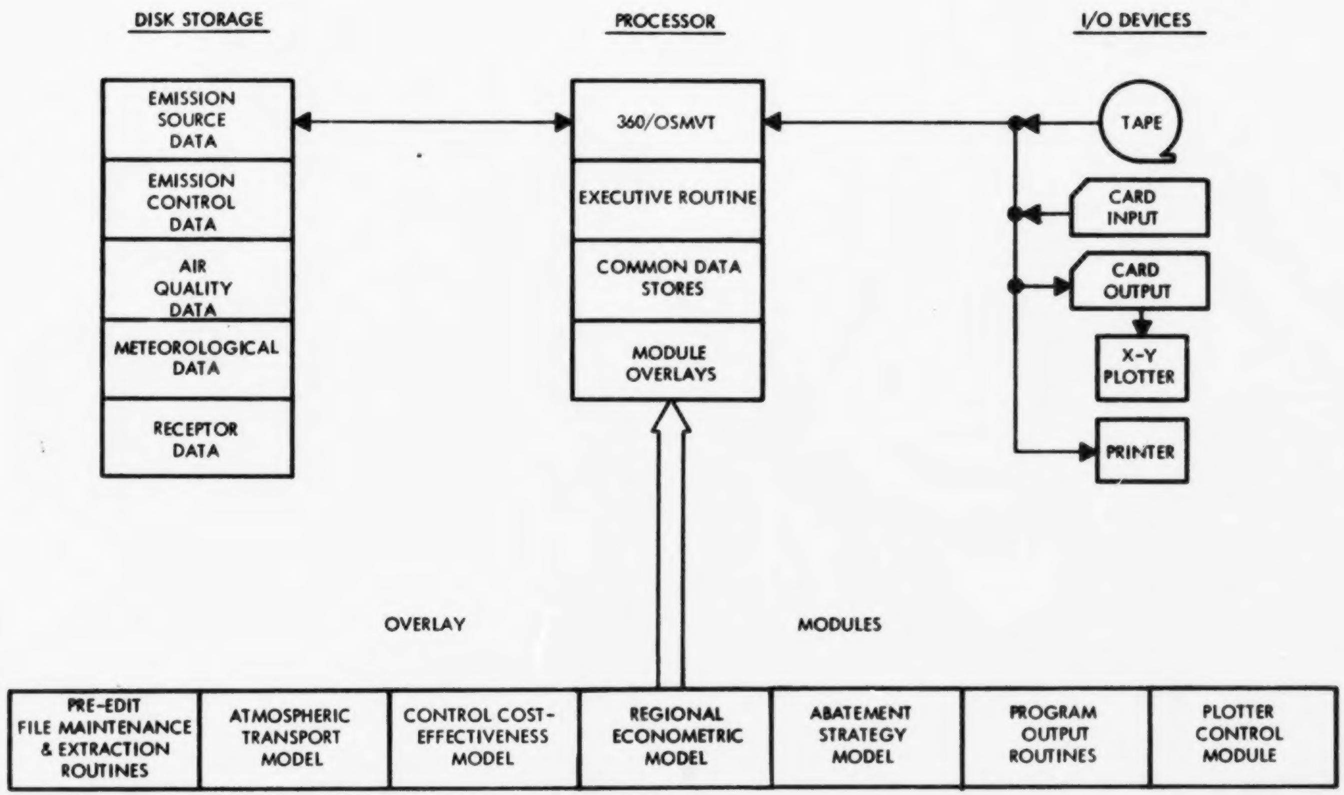

DISK STORAGE
PROCESSOR
I/O DEVICES
EMISSION SOURCE DATA
EMISSION CONTROL DATA
AIR QUALITY DATA
METEOROLOGICAL DATA
RECEPTOR DATA
360/OSMVT
EXECUTIVE ROUTINE
COMMON DATA STORES
MODULE OVERLAYS
TAPE
CARD INPUT
CARD OUTPUT
X-Y PLOTTER
PRINTER
OVERLAY
MODULES
PRE-EDIT FILE MAINTENANCE & EXTRACTION ROUTINES
ATMOSPHERIC TRANSPORT MODEL
CONTROL COST-EFFECTIVENESS MODEL
REGIONAL ECONOMETRIC MODEL
ABATEMENT STRATEGY MODEL
PROGRAM OUTPUT ROUTINES
PLOTTER CONTROL MODULE

FIGURE 3-1 RAPA System Configuration

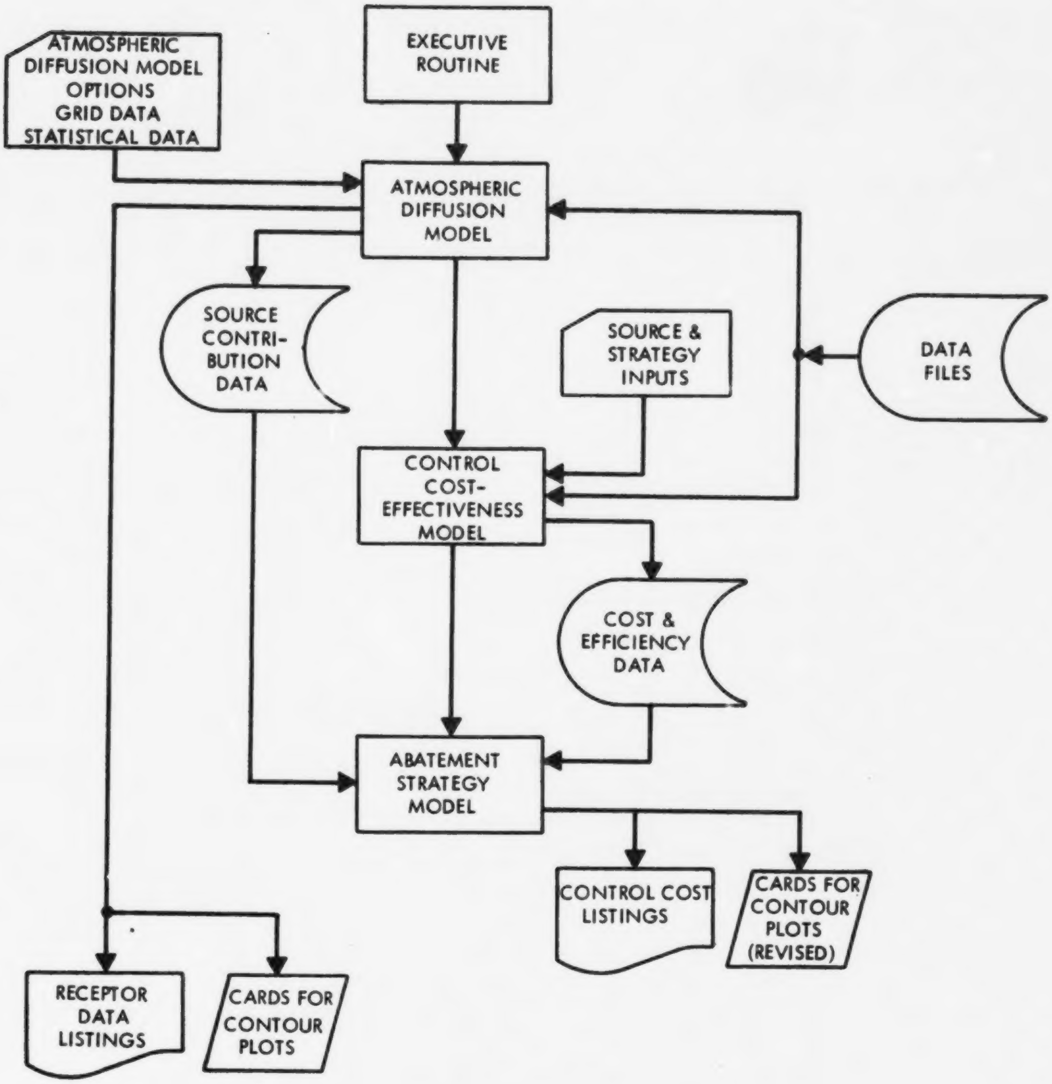

ATMOSPHERIC DIFFUSION MODEL OPTIONS GRID DATA STATISTICAL DATA
EXECUTIVE ROUTINE
ATMOSPHERIC DIFFUSION MODEL
SOURCE CONTRIBUTION DATA
SOURCE & STRATEGY INPUTS
DATA FILES
CONTROL COST-EFFECTIVENESS MODEL
COST & EFFICIENCY DATA
ABATEMENT STRATEGY MODEL
CONTROL COST LISTINGS
CARDS FOR CONTOUR PLOTS (REVISED)
RECEPTOR DATA LISTINGS
CARDS FOR CONTOUR PLOTS

FIGURE 3-2 RAPA Operational Flow Diagram

each model, the Executive Routine will determine if any more models are to be executed, and, if so, will pass control to the appropriate model.

Due to the size of the individual models within the RAPA program, not all segments of a single model will be in the computer at the same time. Therefore, the Executive Routine will bring model segments from an external storage device (dish memory) and store them in the computer as required. Several program segments will occupy the same portion of the computer's memory, but at different times. This process is referred to as overlaying. The Executive Routine will maintain program continuity while overlaying various program segments.

3.2.2 Data Base

The relevant air pollution and air pollution control information, which constitutes the RAPA program data-base, has been obtained from NAPCA documents. In many instances this data was augmented by engineering judgment to compensate for data gaps and program requirements.

Most of the source emission data available to NAPCA has been acquired on the basis of the "Rapid Survey" technique [Ozolins and Smith, 1966]. This is very useful for evaluating the gross emission inventory in a region. The purpose of the "Rapid Survey" inventory is to get an estimate of the existing pollutant effluents. There is no specific attempt made to identify the type of control equipment which may be in use. This leads to an inventory which has only the minimum of the necessary information. There is no information from which the stack plume dispersion factors, such as stack height, stack diameter, exit-gas volume, and exit-gas temperatures, can be computed. In most cases, the sum total of emissions from all individual processes at a given industrial plant are reported without any breakdown as to individual processes. The identification of existing control equipment is not included because it is not a necessary part of a "Rapid Survey."

The use of this information has led to a series of assumptions in the RAPA program. In many instances, it was necessary to make assumptions about the individual processes which make up a given source emission. Steel mills, for example, are made up of a number of processes, such as basic oxygen furnaces, sintering plants, coke ovens, scarfing machines, and miscellaneous smaller operations. By referring to published information on the operational processes in the steel industry, a number of the specific processes currently in use at the steel plants in the St. Louis area were identified. The control cost-effectiveness information, which is being provided about the steel industry as well as all the other industries, starts with the final emissions reported in the NAPCA inventory file. As individual processes are identified, their emission factors have been developed from the available information published by NAPCA and elsewhere. The application of control devices to these potential emissions has been adjusted in order to come up with the final emissions reported in the NAPCA inventory. It has been necessary to develop, independent of the available NAPCA emission data, the process-gas volumes, gas temperatures, gas corrosive conditions, and all of the other information required as input for the Control Cost-Effectiveness Model.

This procedure has been repeated for each of the sources in the St. Louis inventory file. Recognizing the need for a complete set of data to operate the demonstration program, assumptions have been made on the basis of "best" technical judgment. An example of the estimates that have been reached concerns the stack exit velocity required as an input to the Atmospheric

Diffusion Model. There was no information on stack exit velocities in the NAPCA inventory data. Standard practice in industry is to have exit velocities between 2,000 and 4,000 feet per minute. In most cases, velocities of either 3,000 or 3,500 per minute were used as an assumed stack exit velocity. On this basis, the demonstration will have a semblance of reality, although the inaccuracy of these estimates must be considered when interpreting the demonstration results. Likewise, there was no information on stack height; with the exception of some power plants, common practice is to have stacks between about 40 and 200 feet. By referring to standard practice in the various industries, again information was estimated within the correct order of magnitude for stack height.

Perhaps the most critical of the assumptions pertains to the gas volume at various industrial processes. The cost of control devices, as reported in the control technique documents, is based on the ACFM (actual cubic feet per minute of gas volume) passing through the device. In many cases, reference to published literature indicated reasonable estimates of these gas volumes and the associated gas temperatures.

The data format and definitions used in the RAPA program are discussed in the following chapters which deal with computational models that use the information. A sample of the source emission and control cost files are shown in Table 3-1.

3.2.3 Data Files

The data in the RAPA files have been organized to facilitate their use by the computational models. This has reduced the need for special extraction routines for each of the computational models.

Of the four program models, only two have direct needs for file data (Atmospheric Diffusion Model and Control Cost-Effectiveness Model). The

TABLE 3-1 SAMPLE DATA FILE RECORDS

```
**************************************************************** COST EFFECTIVENESS FILE ********************************************

   RECORD KEY=201 09000100C  SKILLED LABOR RATE=              UNSKILLED LABOR RATE=  2.59     MANAGERIAL LABOR RATE=
                                  SALES TAX RATE=                        TAX CREDIT=                  INTEREST RATE=  6.5
                                 OPERATING TIME= 5840                      GAS TEMP=  495              COAL #1 HEAT=     23
                                    COAL #2 HEAT=                      COAL #3 HEAT=                    OIL #1 HEAT=
                                     OIL #2 HEAT=                       OIL #3 HEAT=                       GAS HEAT=
                                    COAL #1 COST=  6.5                 COAL #2 COST=                   COAL #3 COST=
                                     OIL #1 COST=                       OIL #2 COST=                    OIL #3 COST=
                                        GAS COST=                 STACK HGT. LIMIT=            ELECTRICITY COST= .165
                                 EFFICIENCY SOX=                     EFFICIENCY CO=            EFFICIENCY PARTIC= 98.
                                 PRICE #1 COEFF= 42.413             PRICE #2 COEFF=   .623       PRICE #3 COEFF=  0.
                                  ERECTION COST=                          A & E FEE=              AUXILIARY EQUIP=
                                UTILITY CONNECT=                          START UP=                  SPARE PARTS=
                                     LAND & BLDG=                       TRANS. COST=                INSTALL COST= 100
                                    DEVICE LIFE= 15                  PRESSURE DROP=  1                LIQUID USED=
                                    LIQUID COST=                 SOX DISPOSAL COST=            CO DISPOSAL COST=
                             PART DISPOSAL COST=                  ELECTRICITY USED=   29.2                FUEL COST=
                                  FUEL QUANTITY=                  SKILLED LBR. HRS.=         UNSKILLED LBR. HRS.=  8750
                                  MGR. LBR. HRS.=                     ALT. FUEL COST=              ALT. FUEL HEAT=
                                  PLANT CAPACITY=   54.5   PROJECTED ANNUAL COST=              PROJ. EFF. SOX=
                                   PROJ. EFF. CO=                 PROJ. EFF. PARTIC=               NEW EXIT TEMP=  495
                                   CATALYST USED=                     CATALYST COST=              OTHER FS COST=
**************************************************************************************************************************************
```

TABLE 3-1 SAMPLE DATA FILE RECORDS (CONTINUED)

```
*************************************************** SOURCE EMISSION FILE *********************************************
 RECORD KEY=20100910

                          UNITS= K                     LOCATION X=  90.3                      LOCATION Y=  69.0
                           AREA=                           LINE X=                                LINE Y=
                      OWNERSHIP= P              SULF. CONT. COAL= 41               SULF. CONT. COAL #2=
            SULF. CONT. COAL #3=                 SUIF. CONT. OIL=                   SULF. CONT. OIL #2=
             SULF. CONT. OIL #3=                 SUIF. CONT. GAS=                   SULF. CONT. OTHER=
          PROCESS UNITS OTHER=                    PROCESS TYPE= FO                        STACK HGT.=  23
                     STACK DIA.=  1.41           EXIT VELOCITY= 15.2                   EXHAUST TEMP=  505
               EXHAUST PRESSURE=                     D.V. SUMMER= 2                       D.V. WINTEP= 2
                   D.V. ANNUAL= 2.0              EXHAUST CTL. ID=  0                   CTL. EFF. PART.=  0.
   PROC. RATE SUMMER COAL #1=  109.6   PROC. RATE SUMMER COAL #2=        PROC. RATE SUMMER COAL #3=
     PROC. RATE SUMMER OIL #1=          PROC. RATE SUMMER OIL #2=         PROC. RATE SUMMER OIL #3=
        PROC. RATE SUMMER GAS=          PROC. RATE SUMMER OTHER=         PROC. RATE WINTER COAL #1=  109.6
   PROC. RATE WINTER COAL #2=          PROC. RATE WINTER COAL #3=         PROC. RATE WINTER OIL #1=
     PROC. RATE WINTER OIL #2=           PROC. RATE WINTER OIL #3=           PROC. RATE WINTER GAS=
      PROC. RATE WINTER OTHER=         PROC. RATE ANNUAL COAL #1=  109.6  PROC. RATE ANNUAL COAL #2=
   PROC. RATE ANNUAL COAL #3=           PROC. RATE ANNUAL OIL #1=         PROC. RATE ANNUAL OIL #2=
     PROC. RATE ANNUAL OIL #3=              PROC. RATE ANNUAL GAS=          PROC. RATE ANNUAL OTHER=
  PROCESS PROJECTION SUMMER=          PROCESS PROJECTION WINTER=        PROCESS PROJECTION ANNUAL=
   EMISSION FACTOR COAL SOX=  156.       EMISSION FACTOR OIL SOX=          EMISSION FACTOR GAS SOX=
  EMISSION FACTOR OTHER SOX=            EMISSION FACTOR COAL CO=    3.      EMISSION FACTOR OIL CO=
      EMISSION FACTOR GAS CO=           EMISSION FACTOR OTHER CO=      EMISSION FACTOR COAL PART=  110.3
    EMISSION FACTOR OIL PART=           EMISSION FACTOR GAS PART=     EMISSION FACTOR OTHER PART=
    EMISSION RATE SUMMER SOX=   9.05     EMISSION RATE SUMMER CO=   0.    EMISSION RATE SUMMER PART=  11.56
    EMISSION RATE WINTER SOX=   9.05     EMISSION RATE WINTER CO=   0.    EMISSION RATE WINTER PART=  11.56
    EMISSION RATE ANNUAL SOX=   9.05     EMISSION RATE ANNUAL CO=   0.    EMISSION RATE ANNUAL PART=  11.56
**********************************************************************************************************************
```

Abatement Strategy Model and Regional Econometric Model can rely on data already computed and loaded into common core storage or computed by the previous models.

The files for disk storage have been structured so that only those fields or elements related to a particular task reside within one file. A model desiring input data may call in several files from disk; it will receive only the data it needs -- no more.

Based on the grouping of data described above, the following files have been designed to comprise the disk file data base:

(a) Source Emission Data File

(b) Meteorological Data File A

(c) Meteorological Data File B

(d) Control Cost-Effectiveness File

These files, generated and maintained by a generalized file maintenance routine will reside on disk, thereby allowing optimum access time in supporting both file maintenance and data retrieval functions.

3.2.4 File Input, Generation and Maintenance

The RAPA program has the provisions for creating a new file from input data, making new entries in the file, modifying all or part of existing entries, and deleting entire entries.

The routines that perform these functions are the "pre-edit" routine and the "generalized file maintenance" routine.

Figure 3-3 shows the overall system flow of the pre-edit and the generalized file maintenance routines. The initial phase accepts the new data and connects it from an input form to a form that permits efficient updating in the generalized file maintenance routine. In making this conversion, the program produces a list of detected user-errors as a by-product.

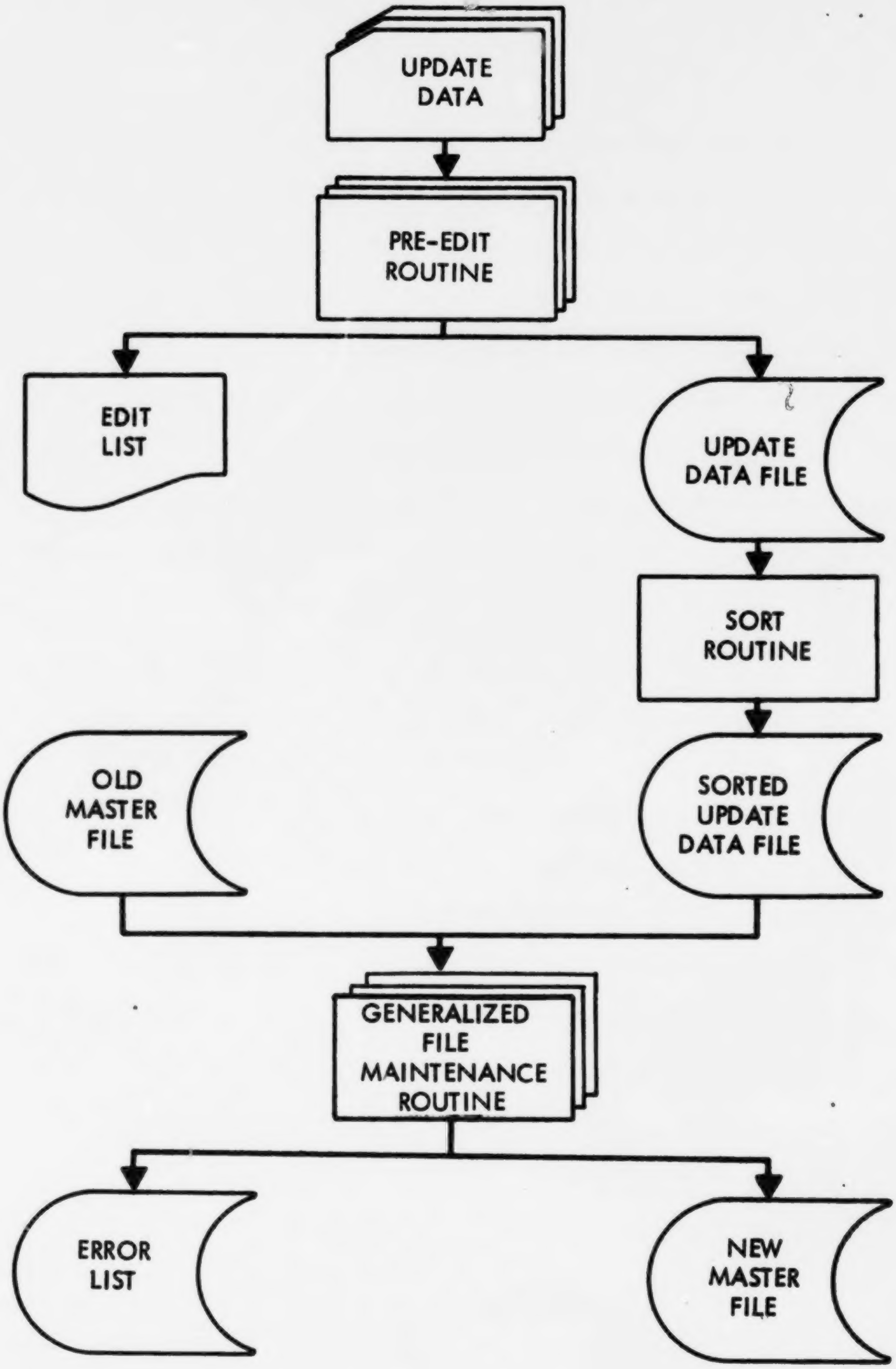

UPDATE DATA
PRE-EDIT ROUTINE
EDIT LIST
UPDATE DATA FILE
SORT ROUTINE
OLD MASTER FILE
SORTED UPDATE DATA FILE
GENERALIZED FILE MAINTENANCE ROUTINE
ERROR LIST
NEW MASTER FILE

FIGURE 3-3 Pre-Edit & Generalized File Maintenance Routines

The output of this routine when sorted according to key sequence, becomes the input to the generalized file maintenance routine. The final phase of the system consists of processing the old data file to produce the new master file. This file is now a product of both the old data file and the edited new data which were processed against it.

File maintenance capabilities for this system provide the ability of adding, deleting or changing any data element within each of the files. In supporting this function, the pre-edit phase generates for the user an extensive file-edit listing, which serves as a basic reference document relevant to the content of the respective data file.

3.3 OPERATIONAL INSTRUCTIONS

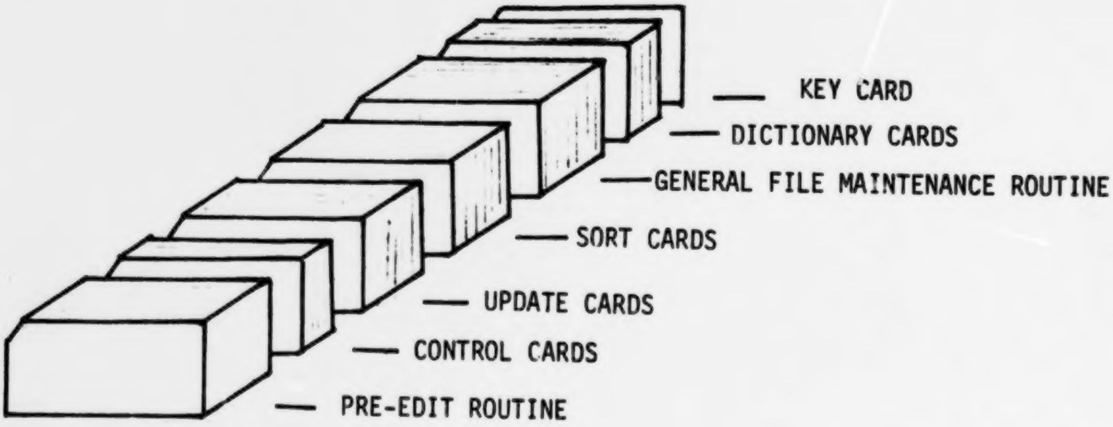
3.3.1 Pre-Edit Routine

The pre-edit and generalized file maintenance (GFM) routines have been designed to afford maximum ease in generating and updating the various files used in the system. The following instructions define user requirements necessary to perform this function.

The card deck which comprises any GFM update consists of Pre-Edit Control Cards, Update Data Cards, Sort Cards, Dictionary Cards, and a Key Card. The structure of this deck is shown in the sketch below.

The pre-edit routine requires the user to provide the following control cards in the job stream:

(a) Title Card - allows the user to write a title on each page of the output from the pre-edit routine. Columns 1-6 contain TITLE= and the desired title is centered in Columns 7-80.


KEY CARD
DICTIONARY CARDS
GENERAL FILE MAINTENANCE ROUTINE
SORT CARDS
UPDATE CARDS
CONTROL CARDS
PRE-EDIT ROUTINE

PRE-EDIT PROGRAM - CONTROL CARDS

(b) Key Length Card - defines the number of characters in the key field Columns 1-13 contain KEY LENGTH=nn, where nn is the number of characters in the key.

PRE-EDIT PROGRAM - UPDATE DATA CARDS

(a) Maximum length of a single field is 1,000

(b) Maximum key length is 1,000

(c) ADD or CHANGE cards enter the pre-edit routine in the following format:

	Field	Length-Contents
1)	Type	A (add) or C (change)
2)	Key Value	1-1,000 characters
3)	Field Name	3 (001-255)
4)	=	1
5)	Contents of Field	1-1,000 characters
6)	Delimiter	1 (asterisk)

3 through 5 are repeated until the card is full. Then another card is started, repeating Type and Key. Thus, it is possible for a field's contents to overlap two or more cards. Field Name never overlaps.

(d) When a card is found to contain an unfinished field (no asterick), build the incomplete field in a separate area until the field is completed. (One field can occupy as many as eleven cards.) As soon as the field is completed, see if it will fit on the record; and if it won't, put out the record. Begin a new record for remaining fields. The resulting file will be unblocked format, with maximum record size 500. Immediately after the Key an absolute sequence number is placed in each record so that, during the subsequent sort, update records will be arranged in sequence number within key order. This will insure that update transactions are processed in the order they were originally arranged in the deck.

	Field	Length
1)	Type	1
2)	Key	1-50
3)	Sequence Number	5
4)	Field Name	3
5)	=	1
6)	Contents	1-254
7)	Asterisk	1

(e) ADD cards for any single record are limited to a total of 1,000 characters, computed as follows:

> Length of key field, plus one, plus length of all data between equal sign and asterisk.

(f) A card punched in the following format must precede all ADD, CHANGE, or DELETE cards: c.c.1-13 KEY LENGTH=nn, where nn is equal to the number of characters in the key.

To Add a Record

Example: To add a record with the key field being 007.

DICTIONARY

FIELD		SIZE
000		003
001		005
003		014
004		015
007		002
008		010
009		001
017		004
KEY	=	007

OLD MASTER FILE

Key 000	001	003	004	007	008	009	017
270	xxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxxx	27	xxxxxxxxxx	0	xxxx
271	xxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxxx	27	xxxxxxxxxx	1	xxxx
275	xxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxxx	27	xxxxxxxxxx	5	xxxx
279	xxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxxx	27	xxxxxxxxxx	9	xxxx

NEW MASTER FILE

```
                                                         0
Key                                                      0
000  001       003             004          007      008      9  017
270 xxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxx 27 xxxxxxxxxx 0 xxxx
271 xxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxx 27 xxxxxxxxxx 1 xxxx
275 xxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxx 27 xxxxxxxxxx 5 xxxx
276 ƀƀƀƀƀ FIELDƀ3ƀDATAƀƀ ƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀ 27 xxxxxxxxxx 6 DATA
279 xxxxx xxxxxxxxxxxxxx xxxxxxxxxxxxxxx 27 xxxxxxxxxx 9 xxxx
```

ADD card:

```
A276003=FIELDƀ3ƀDATA*007=27*009=6*017=DATA*
```

The content of the DATA FIELD must be prefaced with an = sign and terminated with an*.

Only entire records may be added to a file. To add a field to an existing record, enter a CHANGE card.

To Change a Record

To change the contents of a field or fields in a record, use the same techniques as in adding a record. The difference is that in this case there must be an existing record with the key shown in the update record, and the update record code is C rather than A in position 1.

Example: To change field No. 017 on record No. 276 as shown above.

OLD MASTER FILE

```
                                                         0
                                                         0
Key 001          003            004          007      008      9  017
276 ƀƀƀƀƀ FIELDƀ3ƀDATAƀƀ ƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀ 27 xxxxxxxxxx 6 DATA
```

CHANGE card submitted: `C276017=INFO*`

NEW MASTER FILE

```
276 ƀƀƀƀƀ FIELDƀ3ƀDATAƀƀ ƀƀƀƀƀƀƀƀƀƀƀƀƀƀƀ 27 xxxxxxxxxx 6 INFO
```

To Delete Records

Example: To delete a record - (Delete record with key 275)

```
                        KEY
    Old Master File:    270
                        271
                        275
                        279
```

New Master File: 270
271
279

DELETE card: D275

A DELETE card must be submitted for each record to be dropped from the File.

Cards are edited for the following conditions:

(a) Update code must be A, C, or D

(b) Field name must be numeric and followed by an equal sign.

(c) If there is no closing delimiter (*), the following card must have the same key and code. The overlapping field is continued, immediately following the key.

3.3.2 Generalized File Maintenance Routine User Specifications

Purpose - To provide file maintenance and update capability for files in 360 format.

It is possible to add, change and delete records and field contents.

File sequence is ascending by key. If changes are made to the key in an update run, the new master must be re-sorted to reflect the new sequence.

In adding records to the file, it is necessary to specify only those fields which contain a value; the rest of the record is blank-filled.

Changes are left-justified in their fields, and it is necessary to specify the contents only as far as the right-most character of data; the remainder of the field is blank-filled. To blank out a field in a record, specify one blank position for the field.

Deletions are for single records only.

There may be as many as 100 fields, and each may be 1,000 characters long.

The File Dictionary is a deck of cards showing field name and length for each field in the record layout.

Update records and administrative cards are edited to detect the following possible errors:

(a) The Dictionary (on cards) must define every field which appears in the file

(b) The Key card must follow the Dictionary cards immediately

(c) A matching record must be found on the file for deletions and changes

(d) No record may be added for which a record already exists with the same key

(e) The data shown for a field on an ADD or CHANGE record cannot be longer than the field length shown in the Dictionary for that field.

In the event that any of the above errors is detected, a message describing it is printed. In the case of a Dictionary error or Key card error, the job terminates. In the case of error 5, wrong field length, that field is not changed, or if it is an ADD record, blanks are inserted in that field. If error 3 or 4 occurs, the offending record code and key are printed out with an explantory message; and no action is taken for that key.

Counts are kept of the number of addtions, changes, deletions, and the total number of records in the old file and the new.

The old and new Dictionaries and the key card are printed out.

Card Input

Dictionary Cards.

This deck of cards describes the record layout of the updated file and controls the writing out of the new fields, shortening or lengthening of existing fields, and eliminating fields from the file.

CC 1	D
CC 2-4	field name
CC 5	=
CC 6 thru 8	field length
CC 9	, or blank

Repeat columns 2 through 9 until the card is full. Then go on to another card, and repeat until all fields to be on the updated file are included.

To delete a field from every record on the file, show its length as 000.

DICTIONARY CARD FORMAT

FIELD	COLS
CODE	1
KEY NO.	2-3 (for 'K' code only .01)
ID	4-33
START POSIT	34-37
FLD LENGTH	38-41

CODES

x = denotes end of Dict.
ƀ or 0 = denotes old Dict. (i.e. of old mstr)
K = denotes Key field

Key Card

This card defines the field which will be the Key. There can be only one field in the Key.

CC 1	K
CC 2-4	field name

Key Card Field Control:

If any punch other than blank appears in column 79, there will be no update data for this run. If such a punch appears in column 80, there will be no old master file.

Master Input and Output

The file is described by its dictionary cards, which are included for each job run. They are the same length as the data records on the file. The file may be unlabeled and unblocked, if specified.

Position

1	thru	n	Blank key field
n+1	thru	n+3	File record length
n+4	thru	n+6	Number of dictionary records
n+7	thru	n+9	Field name
n+10	thru	n+12	Field length
n+13	thru	n+15	Starting location in record

Repeat positions n+6 thru n+15 until each field in the record is named and defined. Following the last field starting location is a K, followed by the 3-position field name of the field, which makes up the current key for the file.

Data records on the file consist of a key followed by the main part of the record.

3.4 REFERENCE

Ozolins, G. and Smith, R., "A Rapid Survey Technique for Estimating Community Air Pollution Emissions," U.S. Dept. of Health Education and Welfare, Public Health Service, Division of Air Pollution, Cincinnati, Ohio, October 1966.

4. ATMOSPHERIC DIFFUSION MODEL

4.1 PURPOSE

The purpose of the Atmospheric Diffusion Model is to provide transfer functions between individual source emissions within the region and pollutant concentration values at selected sites. The transfer functions are used by the Abatement Strategy Model to determine the effects of various source emission control strategies on the region's air quality levels. The model also provides estimates of regional air quality values so that they may be compared with stated air quality goals.

4.2 DESIGN SUMMARY

Since the objective of the Atmospheric Diffusion Model is to produce the estimated annual average short-term peak concentrations as well as the long-term influence of each source at each receptor point, a combination of two modeling techniques is used. These techniques consist of the Martin-Tikvart diffusion model [Martin and Tikvart, 1968] which transforms the source emission data into long-term average pollutant concentrations, and a statistical model, Larsen [1968], which then determines the expected maximum concentrations and selected percentile concentrations. Although the statistical model is described here as an integral part of the Atmospheric Diffusion Model, it should be noted that it is also used by the Abatement Strategy Model for similar output purposes. Selection of these particular models is based on the fact that both of them have been in use for some time and are capable of producing reasonably accurate results.

The model of the diffusion equation is based on a modified version of the well-known Gaussian-plume equation for an elevated, continuously emitting point source. In its modified form the model gives the long-term (arithmetic) average concentration, at ground level, resulting from specified point and area sources. For each receptor location the model sums the effects of all sources for all combinations of wind direction, wind speed and stability class, as observed for the area and time period of interest. The model is capable of providing long-term average concentration estimates for any or all of the time periods (summer, winter or annual) and for each or all of the pollutant types (SO_x, CO and particulates). If measured pollutant-concentration data is available, it may be used to calibrate the diffusion model. The calibration procedure is to use the least-square regression line of measured concentrations on calculated concentrations (for each pollutant-time period combination) to adjust the model output at all receptor locations. In each case the coefficient of correlation is calculated and compared with its maximum chance value at a 5% confidence level. If the coefficient of correlation is less than its maximum chance value, the regression line is not used, and the model is left uncalibrated for that particular pollutant and time period. On the other hand, if the coefficient of correlation exceeds its maximum chance value, then the correlation coefficient is used to modify the calculated concentration values.

The statistical segment uses the arithmetic average concentrations, calculated by the diffusion model, and input values of the geometric standard deviations for each pollutant-time period combination to determine the expected maximum concentrations and various percentile concentrations at different averaging times. The key assumptions involved in the use of this model are: (1) ground-level air pollutant concentrations are approximately lognormally distributed for all pollutants and for all averaging times, and (2) the median concentration (50 percentile) is proportional to averaging time to an exponent.

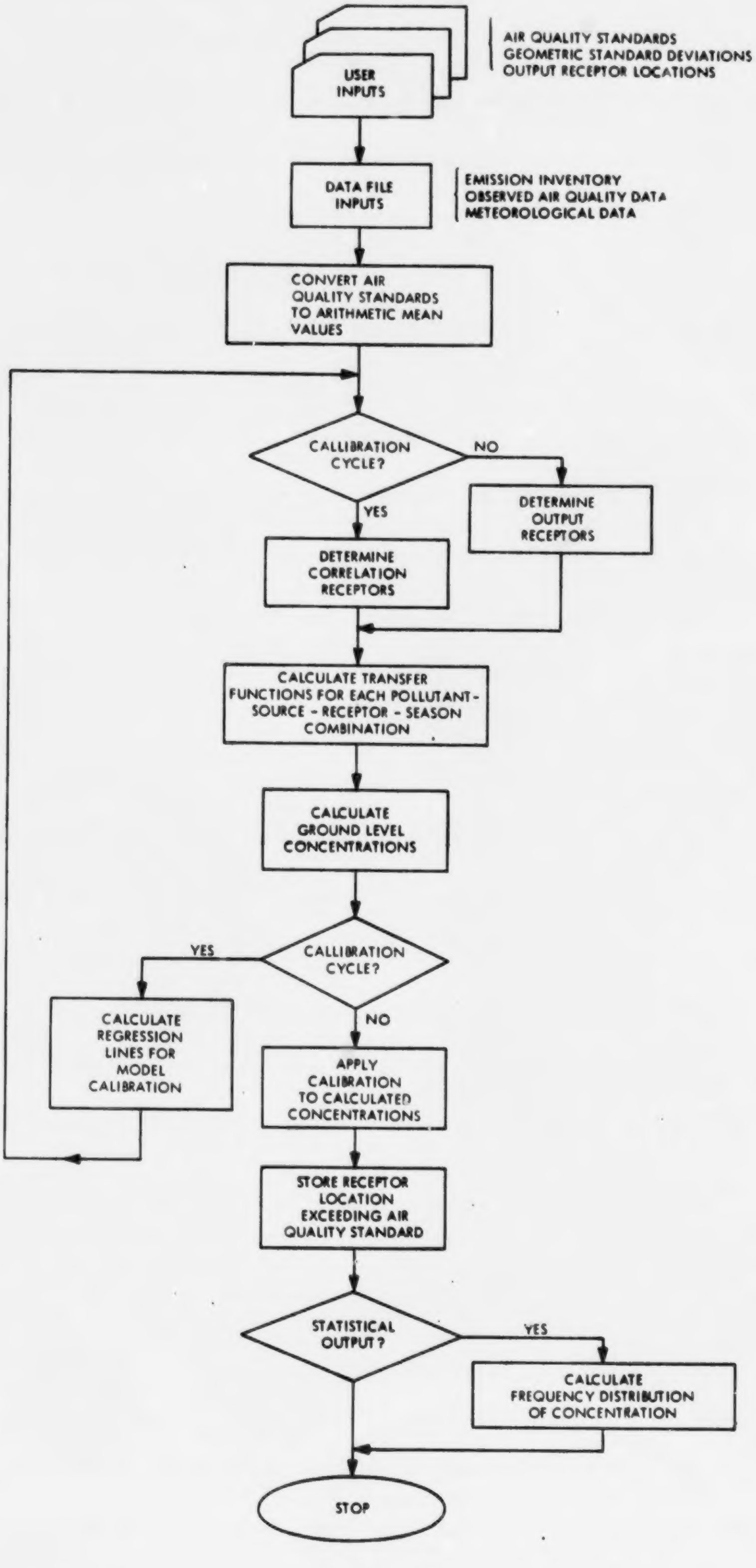
Figure 4-1 summarizes the basic Atmospheric Diffusion Model operations with the correlating and statistical segments. First, the input data is pre-processed and, if applicable, the input air quality standards are converted to arithmetic mean values for comparison with calculated values. Then, if measured concentration values are available, the model calculates theoretical average concentrations at the measuring sites and the linear regression lines are obtained for model calibration. The model then is used to obtain the average gound-level concentration values at user-selected receptor points within the region.

After calculating the concentration values for each specified receptor location, the data for each pollutant-season combination are stored for use in the Abatement Strategy Model. This data consists of the arithmetic mean for each receptor-season-pollutant combination, and the transfer function relating each source to each receptor during each time period. Use of the transfer function allows the Abatement Strategy Model to alter the source values in the emission inventory and recalculate the concentration levels without a rerun of the diffusion model. Finally, if desired, the statistical model is used to convert the arithmetic mean values to expected maximum and various percentile concentrations for various averaging times.

4.3 MODEL DESCRIPTION

4.3.1 Atmospheric Diffusion Model

The diffusion model is based on the well-known Gaussian-Plume equation for an elevated, continuously emitting point source [Pasquill, 1962]. However, this is first appropriately modified to give the long-term

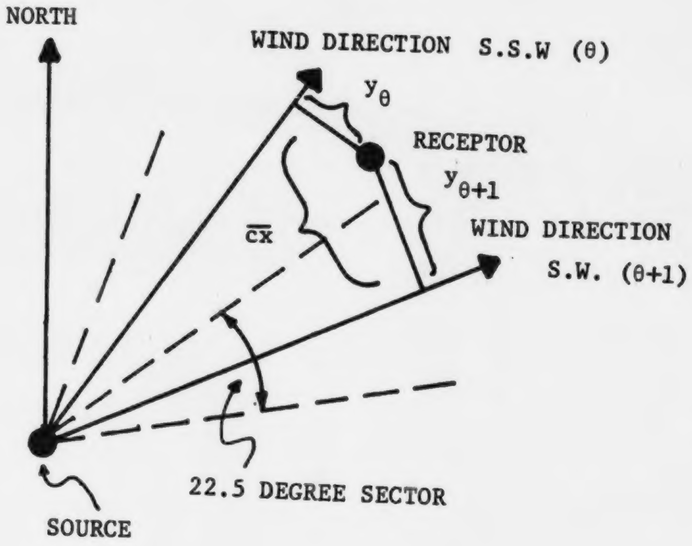


USER INPUTS
AIR QUALITY STANDARDS
GEOMETRIC STANDARD DEVIATIONS
OUTPUT RECEPTOR LOCATIONS
DATA FILE INPUTS
EMISSION INVENTORY
OBSERVED AIR QUALITY DATA
METEOROLOGICAL DATA
CONVERT AIR QUALITY STANDARDS TO ARITHMETIC MEAN VALUES
CALLIBRATION CYCLE?
NO
DETERMINE OUTPUT RECEPTORS
YES
DETERMINE CORRELATION RECEPTORS
CALCULATE TRANSFER FUNCTIONS FOR EACH POLLUTANT - SOURCE - RECEPTOR - SEASON COMBINATION
CALCULATE GROUND LEVEL CONCENTRATIONS
YES
CALLIBRATION CYCLE?
CALCULATE REGRESSION LINES FOR MODEL CALIBRATION
NO
APPLY CALIBRATION TO CALCULATED CONCENTRATIONS
STORE RECEPTOR LOCATION EXCEEDING AIR QUALITY STANDARD
STATISTICAL OUTPUT?
YES
CALCULATE FREQUENCY DISTRIBUTION OF CONCENTRATION
STOP

Figure 4-1. Atmospheric Diffusion Model

arithmetic average concentration at any receptor from a given source. This is possible when allowance is made for the joint frequency of occurrence of all possible combinations of wind direction, wind speed and stability class, as observed for the area of interest. The concentration contributions at the receptor then are summed over all the sources.

Although the wind direction is a continuous variable, for purposes of computation it is specified with respect to a 16-point compass (corresponding to 22.5-degree circular sectors). For any averaging period (i.e., seasonal or annual), it is assumed that all wind directions within a given 22.5-degree sector occur with equal probability. It then can be assumed that the effluent is uniformly distributed in the horizontal within the sector. However, since the wind does not blow with equal frequency from all directions, this assumption would result in a finite step in calculated concentration values when crossing a sector boundary (i.e., the long-term formulation would not be continuous with respect to wind direction). A more reasonable distribution is obtained by using a linear interpolation between sector center-lines. Thus, the concentration at a given receptor location is composed of proportional contributions from both the sector containing the receptor and the adjacent sector nearest the receptor. The linear-interpolation term is given by $(\overline{cx} - y)/\overline{cx}$, where y is the cross-wind distance of the receptor from the center-line of the sector being considered and $\overline{cx}$ is the sector width at the receptor location. This concept is illustrated in the following below. Note that a S.S.W. wind effects the receptor to the N.N.E. of the source.


NORTH
WIND DIRECTION S.S.W (θ)
y_θ
RECEPTOR
$y_{\theta+1}$
$\overline{cx}$
WIND DIRECTION
S.W. (θ+1)
22.5 DEGREE SECTOR
SOURCE

Use of the linear cross-wind distribution, together with the assumption of total pollutant reflection from the ground, reduces the Gaussian-plume equation to:

$$\bar{\chi} = \frac{2Q\ (\overline{cx} - y)/\overline{cx}}{u\ \sigma_z \sqrt{2\ \pi}\ (2\pi\ \rho/16)}\ \exp\left[-\frac{1}{2}\left(\frac{h}{\sigma_z}\right)^2\right], \tag{1}$$

where

χ = ground level pollutant concentration

Q = source emission rate

u = mean wind speed

ρ = downwind source-receptor distance

h = effective source height

σ_z = diffusion parameter, i.e., the standard deviation of the plume concentration distribution in the vertical.. σ_z is a function of both ρ and stability class.

If a stable layer aloft is affecting the distribution, Equation (1) is not valid. The dispersion computation can be modified for this situation by considering the mixing depth, L (i.e., the height of the base of the stable layer), in the following way. Allow σ_z to increase with distance ρ until $\sigma_z = .47$ L. Up to this distance, say ρ_L, the plume is considered to have a Gaussian distribution in the vertical and Equation (1) applies. At distance ρ_L it is assumed that the trapping effect of the mixing-layer lid begins to effect the vertical concentration distribution, and that at distance $2\rho_L$ it results in a uniform distribution. For distances $\rho > 2\rho_L$ the average concentration can be calculated from:

$$\bar{\chi} = \frac{Q(\overline{cx} - y)/\overline{cx}}{L\ u(2\pi\rho/16)} \tag{2}$$

The estimation of $\bar{\chi}$ for a particular source-receptor configuration can be accomplished by choosing a representative wind-speed for each speed class and solving the appropriate equation for all wind-speed classes and stability classes, as observed for the time period and area of interest. The average concentration, χ, then is obtained by summing all concentrations and weighting each one according to its frequency for the particular wind direction, wind-speed class, and stability class. The average concentration can be expressed by:

$$\chi = \sum_{\Theta}\sum_{N}\sum_{S} F(\Theta,N,S)\ \Phi(\Theta,N,S), \tag{3}$$

where

$F(\Theta,N,S)$ = the frequency during the period of interest that the wind is from direction Θ, for the wind speed class class N and for the stability class S.

$\phi(\Theta,N,S)$ = Equation (1) or (2)

For each of the 16 wind-direction categories, wind speed is defined in 6 categories and stability class in 5 categories. Thus, a three-dimensional array of 480 categories is required for each time period considered. When summed over all categories, the relative frequency totals 1.0. This array can be obtained by a special computer program [c.f. Appendix of Martin, 1968], which uses the long-term records of hourly meteorological observations. These records are normally available from Weather Bureau Stations.

The representative wind-speeds, associated with each of the six weather bureau speed categories (0-3, 4-6, 7-10, 11-16, 17-21 and > 21 knots), are given by the mid-interval values .67, 2.46, 4.47, 6.93, 9.61, and 12.52 meters per second respectively. The five stability categories (S = 1, 2, 3, 4 and 5 in order of increasing stability) are defined on the basis of the objective criteria after Turner [1967], and are used in determining both the vertical-diffusion parameter, σ_z, and the effective mixing depth, L. However, for stability class 5, the vertical standard deviation function, σ_z (ρ,s), of the model is calculated as if for S=4.

The values of $\sigma_z(\rho,s)$ used in the program are those of Pasquill [1962], and Gifford [1961]. For convenience, these are represented in the form $\sigma_z = a\,\rho^b + c$, where a, b, and c are constants with values for each stability class, as shown in the table below. The minimum value of ρ, used in calculating σ_z, is 100 meters. If $\rho < 100$ meters, ρ is set equal to 100 meters prior to the σ_z calculation.

Stability Class (S)		a	b	c
1 ∿ Very unstable		.001	1.890	9.6
2 ∿ Moderately unstable		.048	1.110	2.0
3 ∿ Slightly unstable		.119	.915	0.0
4 ∿ Neutral	ρ > 1000 meters	2.610	.450	-25.5
	$\rho \leq$ 1000 meters	.187	.755	- 1.4
5 ∿ Stable	ρ > 1000 meters	52.600	.150	-126.0
	$\rho \leq$ 1000 meters	.135	.745	-1.1

If the stability data cannot be obtained, a first-order approximation of the average concentration values may be made by assuming the neutral stability class only, and using input values of the effective wind-speed for each wind direction, u(Θ), and the relative frequency of occurrence of each wind direction, f(Θ). In this case the frequency array has only 16 categories and the average concentration is expressed by:

$$\chi = \sum_{\Theta} f(\Theta)\ \Phi\ (\Theta) \qquad (4)$$

The f(Θ) and u(Θ) data can be obtained from a special computer program written by Martin [1969]. The final meteorological parameter required by the program is the mixing depth L. This parameter varies highly from season to season, day to day, and diurnally. Since it is virtually impossible to account for all of these variations, a procedure has been adapted in an attempt to reflect the major changes. The procedure is to modify the average afternoon mixing-depth values, as tabulated by Holzworth [1967], according to the stability class being considered. Stability classes S = 1, 2 and 3 are essentially afternoon conditions, with S = 1 corresponding to very unstable conditions. When S = 1, the value of

L is assumed to be 50% greater than the climatological value tabulated by Holzworth, while when S = 2 or 3, the climatological value is assumed. According to the objective criteria of Turner, the stability class, S = 5, can occur only at night under conditions when ground-based inversions would occur for open, level country. Since a shallow layer of neutral or weak lapse-conditions has been found to occur over urban areas, even with strong nocturnal surface inversions on the surrounding rural areas, a mixing depth, L = 100 meters, is assumed for stability class S = 5, when the latter is called for under the objective criteria. This 100-meter value is based on observations by Clarke. To provide for the possibility of mixing-depth values intermediate between the above extremes, it is assumed that L has a value equal to 4/5 of the mean of the climatological afternoon value and the nighttime value of 100-meters, when the objective stability class is S = 4. For S = 2 or 3 and the remaining 1/5 of the S = 4 class, the climatological value is used.

The effective stack height, h, of Equation (1) is defined as the height of the plume center-line when it becomes horizontal. Thus h = h* + Δh where h is the stack height and Δh is the plume-rise. The effective stack height is not used in the uniform mixing equation (2), since for such cases the height of emission is inmaterial.

The plume-rise equation used in the program is due to Holland [c.f. Turner, 1967] and is given by:

$$\Delta h = \frac{V_s d}{u} \left[1.5 + 2.68 \times 10^{-3} P \left(\frac{T_s - T_a}{T_s} \right) d \ (1.4-0.1)S \right], \qquad (5)$$

where

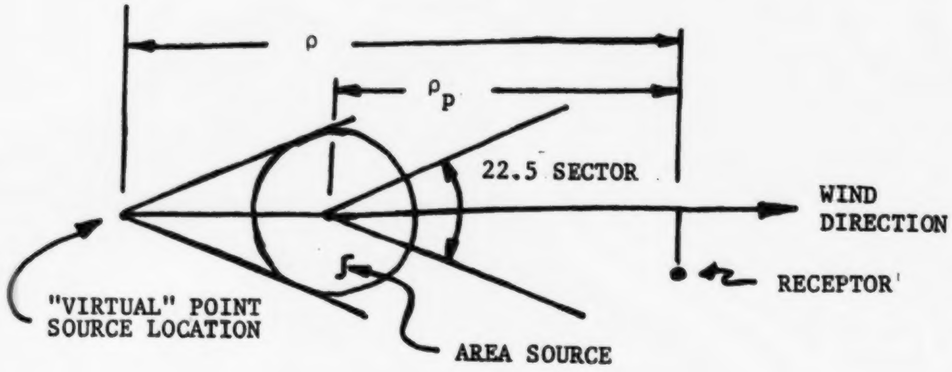
V_s = stack gas-exit velocity, m/sec
d = inside stack diameter, m
u = mean wind speed, m/sec
P = atmospheric pressure, mb
T_s = stack gas temperature, ^oK
T_a = air temperature, ^oK
S = stability class

It should be noted that this equation frequently underestimates the effective height of emission; therefore, its use often provides a slight "safety" factor. For some sources (e.g., power plants with tall stacks) under particular meteorological conditions, the effective height of emission will be above the mixing depth. Based on the assumption that the plume will not disperse downward, these cases are indentified and eliminated from consideration by the program. For area sources an average effective height of emission must be estimated.

The program handles area sources by converting them to equivalent or "virtual" point sources. In the conversion process, both the downwind distance and source strength are dependent on the particular source-receptor configuration.

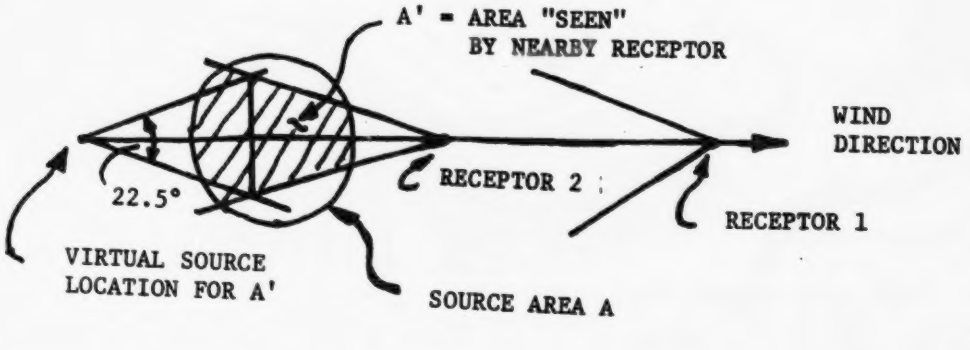
If the total emission is calculated as though at the center of the source area, concentrations downwind tend to be overcalculated, especially for nearby receptors. Since uniform spread across the sector is assumed, it is logical to proceed a step further and assume a virtual point source at such a distance upwind that the source-area diameter subtends the 22.5-degree sector used. This concept is illustrated in the sketch on the following page. Thus, the program uses ρ as the source-receptor distance instead of ρ_P.

In a similar manner, nearby receptors are affected by emissions from only a portion of the source area and, therefore, would be overcalculated if the total area emission value were used. To counter this,



ρ
ρ_p
22.5 SECTOR
WIND DIRECTION
RECEPTOR
"VIRTUAL" POINT SOURCE LOCATION
AREA SOURCE

the source emission rate is multiplied by an "area utilization" factor, Q*, which is the ratio of that portion of the source area lying within a 22.5-degree sector upwind of the receptor (A') to the total area (A). For example, in the sketch below Receptor would use the total area-



A' = AREA "SEEN" BY NEARBY RECEPTOR
WIND DIRECTION
22.5°
RECEPTOR 2
RECEPTOR 1
VIRTUAL SOURCE LOCATION FOR A'
SOURCE AREA A

emission value, Q, while Receptor 2 would use the proportional amount, $QQ^* = Q(A'/A)$. Note that here the virtual point source is defined by the reduced area being subtended at its centroid by the 22.5 degree sector.

Of the three types of pollutants considered by the program, SO_x is the only one for which a reasonable, "average," decay-factor estimate can be made. As a result, the time-decay factor, $\exp[-H(\rho/u)]$, is applied to Equations (1) and (2) only during SO_x calculations. It is an input-constant which determines the rate of decay.

As with all simulation models of this type, a great deal of caution must be exercised in its use. In particular, it is important that both the meteorological data and the source emission data truly represent the region being considered. It is imperative that a meteorologist familiar with diffusion calculations be consulted before the model is applied and that professional assistance be obtained throughout the modeling procedure.

4.3.2 Calibration Segment

If measured pollutant-concentration data is available, it may be used to calibrate the diffusion model. The calibration procedure (repeated for each pollutant-time period combination) first uses the diffusion model to calculate the concentration values at the measuring sites. Then, a least-square regression line of measured concentrations on calculated concentrations is obtained.

Thus, for each pollutant-time period combination there is an equation:

$$\hat{\chi}_{TP} = A_{TP} + B_{TP}\,\chi_{TP}, \tag{6}$$

where

χ_{TP} = calculated concentration for a particular time period and pollutant.

$\left.\begin{matrix} A_{TP} \\ B_{TP} \end{matrix}\right\}$ = regression line constants.

$\hat{\chi}_{TP}$ = measured concentration values.

To determine if the calibration equation should be used, the coefficient of correlation, R_{TP}, is obtained and compared with its maximum chance value at a 5% confidence level (i.e., the maximum value which will arise, due to chance, 5 times out of a 100). If R_{TP} is greater than its maximum chance value, Equation (6) is used to adjust subsequent calculated values. In this case $\hat{\chi}_{TP}$ becomes the new output concentration.

If R_{TP} is less than its maximum chance value, the correlation is assumed poor and the regression line for that time period and pollutant is rejected. Poor correlation should be viewed as a warning to the user that all data and assumptions need review.

4.3.3 Statistical Segment

Larsen [1968] has presented a mathematical model for the expression of air pollution concentration as a function of averaging time and frequency, and has demonstrated how the model can be used to relate air quality criteria to air quality standards and emission standards. The model will be employed here to convert arithmetic average concentrations to expected maximum concentrations and various percentile concentrations for selected averaging times, under the assumption that the geometric standard deviations are known. Output therefore will consist of the following:

(a) Geometric mean for various averaging times.

(b) Maximum expected concentrations for various averaging times.

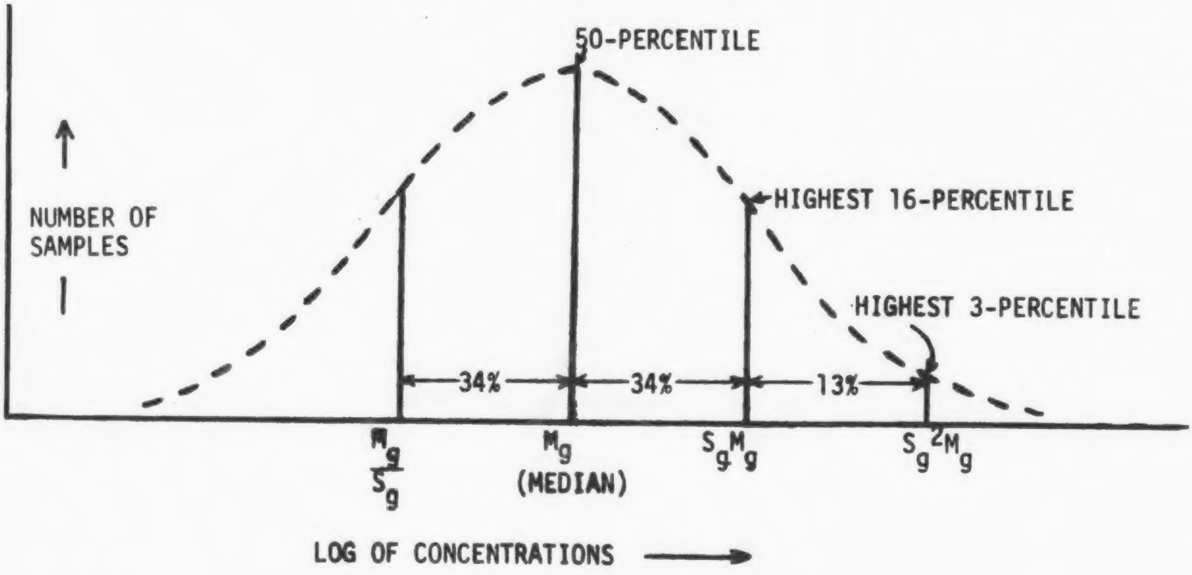
(c) Nth percentile concentration values for various averaging times.

The Larsen model was constructed on the basis of the following characteristics, as observed from analysis of seven pollutants for six cities over a three year period:

(a) Concentrations are approximately lognormally distributed for all pollutants in all cities for all averaging times.

(b) The median concentration is proportional to averaging time to an exponent.

As observed by Larsen, if air quality data for the major cities are plotted on log-probability paper (for given averaging periods), the resulting curves are nearly straight lines. This suggests that, to a good approximation, the distribution of samples follows a lognormal curve. The sketch below is representative of a lognormal curve where the logarithm of concentrations is plotted on the horizontal axis and the number of one-hour samples obtained for each concentration is plotted on the vertical axis.



50-PERCENTILE
NUMBER OF SAMPLES
HIGHEST 16-PERCENTILE
HIGHEST 3-PERCENTILE
34%
34%
13%
$\frac{M_g}{S_g}$
M_g (MEDIAN)
S_gM_g
$S_g^2M_g$
LOG OF CONCENTRATIONS

This curve is the familiar, bell-shaped probability curve, the only difference being that the logarithm of concentration is plotted rather than the concentration itself. The center of such a curve falls not on the arithmetic mean, but on the geometric mean (or median) concentration. This is the concentration which halves the area under the curve, meaning that half of the samples will lie above this value and half will lie below it. As with the normal probability curve, the standard deviation is a measure of the "spread" of the curve. However, for the lognormal distribution, it is called the standard geometric deviation, and is the ratio of the concentration which is exceeded by 66% of the samples to that which is exceeded by 50% of the samples (i.e., the geometric mean).

Since only two parameters are needed to define the shape of this distribution, it is possible, once two parameters are known, to calculate the concentration for any percentile. In addition, since a given averaging period corresponds to a fixed number of samples over a season or a year, the highest sample will correspond to a particular percentile. Thus, it also is possible to calculate the expected maximum concentration for the season or year. Equation (7) is a general relationship for calculating the concentration at any point along the curve as a function of the two parameters, the geometric mean, and the standard geometric deviation.

$$C = M_g s_g^{z} , \tag{7}$$

where

C = concentration corresponding to the desired percentile and averaging time

s_g = standard geometric deviation of samples (at the desired averaging time)

M_g = geometric mean of samples (at the desired averaging time)

z = plotting position which corresponds to the desired percentile

In Larsen's original work, both of the parameters, M_g and s_g, were obtained from the actual distribution of sample data. In the RAPA program M_g is obtained from the theoretical concentration values (arithmetic mean) of the diffusion model. The number of standard deviations on a normal probability curve, z, that corresponds to the desired percentile may be obtained from statistical tables. The table below shows the values of z for several selected percentiles. In the program the z values are obtained by an approximation technique which involves solving the normal, cumulative-probability, density function.

$$P = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{+\infty} e^{-1/2\ z^2} dx.$$

Values of z for Various Frequencies

Highest Percentile	z
50.0%	0.00
30.0%	0.52
15.0%	1.04
10.0%	1.28
5.0%	1.64
1.0%	2.33
0.1%	3.09

Since a particular percentile is associated with the maximum concentration in any set of samples for a specified averaging time, a similar table may be prepared in which the values of z correspond to the maximum concentration for selected averaging times. Such values are listed below and, when used in Equation (7), they permit calculation of the expected maximum concentration in a distribution of samples (for a single averaging time) where M_g and s_g are known.

Values of z for Calculating the Maximum Concentration

Averaging Time	z
1 year	0.00
1 month	1.64
24 hours	2.94
8 hours	3.26
4 hours	3.46
2 hours	3.63
1 hour	3.81

The geometric mean for a given set of samples may be calculated from the arithmetic mean and the standard geometric deviation for that same set of samples in a relatively straightforward manner, as shown in Equation (8).

$$M_g \quad = \quad X / s_g^{\,(1/2 \ln s_g)}, \qquad (8)$$

where

M_g = geometric mean for a set of samples

X = arithmetic mean

s_g = standard geometric deviation for the same set of samples

ln denotes the natural logarithm to the base e.

If s_g is for the desired averaging time, Equations (7) and (8) may be used to provide the desired output. If the desired averaging time is different than the one associated with the input s_g, then s_g must be translated to the desired averaging time. It is assumed that the input S_g corresponds to a 24-hour averaging time.

Larsen proposes a method to make translations between averaging times by assuming that the median concentration is proportional to averaging time to an exponent. The standard geometric deviations for different averaging times may be related as shown in Equation (9);

$$s_{g_n} = \left(s_{g_{24}}\right)^k, \qquad (9)$$

where

$$k = \sqrt{\frac{\ln 8760/n}{\ln 8760/24}}$$

and

s_{g_n} = standard geometric deviation at averaging period of n hours

$s_{g_{24}}$ = standard geometric deviation of 24-hour samples

The statistical relationships described above, along with the annual arithmetic mean concentration computed by the diffusion model, allow the user to estimate the expected maximum and geometric mean pollutant concentration at various averaging times.

Starting with the output of the diffusion model, the annual arithmetic mean concentration for a particular pollutant, the program computes the annual geometric mean and annual expected maximum concentration. Both of these calculations depend on a known value of the geometric standard deviation for a given averaging time. Regardless of which averaging time is desired, a relationship exists for converting the known value of a geometric standard deviation to any other averaging time.

Having computed the expected maximum concentration for the average annual period, the user can request a similar computation for a different averaging period. Under the basic assumption that the expected maximum concentration is inversely proportional to the averaging time to an exponent (i.e., a straight line or a logarithmic plot), only one other point needs to be calculated to define the expected maximum concentration line for all averaging times. The statistical relationships in the AQDM program permit the conversion of the geometric standard deviation to any other averaging time, as well as the computation of a geometric mean and, finally, an expected maximum value for the other averaging time. Now with a second expected maximum value and a second geometric mean value, two straight lines can be defined as the logarithmic plot of concentration versus averaging time.

The user can now read off the expected maximum and geometric mean concentration for all averaging times.

4.4 INPUT DATA REQUIREMENT

Since the Atmospheric Diffusion Model consists of the three distinct segments: diffusion modeling, output calibration, and the statistical calculations, the data requirement unique to each segment will be discussed separately.

4.4.1 Diffusion Model Inputs

Input for the diffusion model consists of meteorological data, source emission data, and receptor-location data.

4.4.1.1 Meteorological Data

(a) Frequency data F(Θ,N,S) - This data provides the frequency of occurrence of each combination of wind direction, wind-speed class, and stability class. Since there are 16 wind directions, 6 wind-speed classes, and 5 stability classes, there are 480 values of F required for each time-period considered.

Although these data can be generated in a variety of ways, it is most conveniently obtained via a computer program written by Mr. J. Tikvart [Martin and Tikvart, 1968]. Raw data input to the Tikvart program consists of 1) latitude and longitude of the city, and 2) standard punched cards of hourly observations recorded at a weather bureau or airport station.

(b) Wind Frequency Data, F(Θ) - As a first-order approximation, the model can be run under the assumption of a single (neutral) stability condition. In this case, separate entries for wind-direction frequency (F) and effective wind-speed (U) are required. Here, F is defined as the frequency with which the wind blows from each of the 16 standard wind directions. It is used in the form F/U where U, also a separate input, is the effective wind-speed associated with each of the wind directions.

(c) Average Afternoon Mixing Depth, (L) - One value of L for each season is required. The program is tailored to use the L values tabulated by Holzworth [1967].

(d) Vertical Diffusion Parameter, σ_{z_c} - σ_z is, calculated from the equation: $\sigma_z = a\rho^b + c$, where a, b, and c are input-constant and ρ is the source-receptor downwind distance. Seven sets of constants are used to define σ_z for all of the stability classes in the program. The σ_z curves recommended for this model are those that have been defined by Pasquill [1962] and Gifford [1961]. If other values are used, such as those of Smith and Singer [1966], it becomes necessary to redefine the stability classes in accordance with their criteria.

4.4.1.2 Source Emission Data

The two types of sources considered are point sources and area sources (assumed square in shape). For each source there is an associated pollutant emission rate for each pollutant-season combination. Unique information for each type of source is noted in the following table. More detailed information is shown in Table 3-1.

Source Type	Location Method	Emission Rate Units	Special Data
Point	Coordinates of Point	Tons/day	Stack information
Area	Coordinates of area centroid	Tons/day	Area size and effective source height

The stack information for point sources is used in the program to calculate the effective stack height. This information consists of the ambient pressure and temperature for each source, the stack diameter and height, exhaust gas temperature, and exhaust gas velocity. For area sources an average effective height of emission must be estimated.

The coordinates of the source locations may be in any of the three systems: 1) Degrees latitude and longitude, 2) kilometers, or 3) kilofeet. If an area source location is given in kilofeet, its area must be given in square miles; otherwise the area is assumed to be square kilometers.

4.4.1.3 Receptor Location Data

A total of 225 receptor locations may be specified as a rectangular grid pattern covering the entire area of interest, together with 12 specified locations. In both cases, the receptor locations are defined with respect to the same system (i.e., origin and units) used for the source coordinate data.

4.4.2 Calibration Segment

The ground-level concentration outputs of the diffusion model may be calibrated for any one or all of the pollutant-season combinations of a given run. The required input data consist of:

(a) Sample Station Locations - from 3 to 20 monitoring station locations, defined with respect to the emission-inventory, coordinate-system and origin.
A single set of station locations must be used for all pollutant-season combinations.

(b) Sample Station Concentrations - for each station used, there will be at least one pollutant-season concentration. The input concentrations are assumed to be arithmetic mean values in parts per million for SO_x and CO, and micrograms per cubic meter for particulates.

4.4.3 Statistical Segment

Inputs for the statistical segment consist of the geometric standard deviations for each pollutant-season combination to be considered and the frequency-distribution parameters desired for output (5 averaging times and 3 percentile concentrations). The geometric standard deviations are assumed to apply to 24-hour averaging times.

In addition, the following data are needed in describing given air quality standards for each pollutant-season combination.

(a) Type of air quality standard:

1 = geometric mean

2 = arithmetic mean

3 = maximum concentration or concentration at a given percentile.

(b) Value of air quality standard.

(c) If Type 3, specify the percentile value. (If no percentile value is specified, a maximum concentration is assumed).

(d) Averaging time of air quality standard.

4.5 OUTPUT DATA OPTIONS

Although the major function of the diffusion model is to provide selected receptor data to the Abatement Strategy Model, it also can be used to produce detailed air quality data.

4.5.1 Tabular Data Outputs

In addition to arithmetic mean concentration values at each receptor, there are 4 "blocks" of information available, any one of all of which may be requested by the user.

(a) Statistical data (Table 4-1) for up to 12 selected receptors (not necessarily the 12 input locations). For each of 5 specified averaging times the program will produce:

- Arithmetic Mean Concentration
- Geometric Mean Concentration
- Geometric Standard Deviation
- Maximum Concentration
- Concentration Values for Each of Three Input Percentiles

(b) Statistical data for up to 50 receptors (Table 4-2) which exceed the air quality standard for each of three pollutants and three seasons, ordered by descending arithmetic means, to include:

- Arithmetic Mean Concentration
- Excess above the Air Quality Standard
- Point Source Contribution to the Total Concentration Value
- Percent emission reduction required to reduce the receptor excess to zero by control of all sources or control of point sources.

(c) Statistical data for the maximum five receptors (Table 4-3) for each of two pollutants and three seasons, or for five selected receptors, to include the percentage contribution from each source to the total concentration at these receptors.

TABLE 4-1 STATISTICAL DATA

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT - PARTICLLATE
SEASON - WINTER

AVERAGING TIME 8. HRS. HAS STANDARD DEVIATICN = 2.17

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	PAXIMUM CCNCENTRATICN	1.0% CONCENTRATION	3.0% CONCENTRATION	5.0% CONCENTRATION
1	7.580203E-07	5.622872E-07	5.C86946E-06	5.086946E-06	5.086946E-06	5.086946E-06
2	1.075715E-06	7.979478E-07	7.218940E-06	7.218940E-06	7.218940E-06	7.218940E-06
3	1.344391E-06	9.972464E-07	9.021971E-06	9.021971E-06	9.021971E-06	9.021971E-06
4	1.619091E-06	1.201015E-06	1.086544E-05	1.086544E-05	1.086544E-05	1.086544E-05
5	1.219570E-06	9.046569E-07	8.184325E-06	8.184325E-06	8.184325E-06	8.184325E-06
6	1.021272E-06	7.575627E-07	6.853580E-06	6.853580E-06	6.853580E-06	6.853580E-06
7	1.575406E-06	1.168610E-C6	1.057227E-05	1.057227E-05	1.057227E-05	1.057227E-05
8	3.907039E-06	2.898177E-06	2.621945E-05	2.621945E-05	2.621945E-05	2.621945E-05
9	4.110050E-06	3.048767E-06	2.758183E-05	2.758183E-05	2.758183E-05	2.758183E-05
10	2.144920E-06	1.591066E-06	1.439419E-05	1.439419E-05	1.439419E-05	1.439419E-05
11	9.175465E-07	6.806210E-07	6.157498E-06	6.157498E-06	6.157498E-06	6.157498E-06
12	1.387619E-06	1.029312E-06	9.312060E-06	9.312060E-06	9.312060E-06	9.312060E-06

TABLE 4-2 STATISTICAL DATA (AIR QUALITY STANDARD)

POLLUTANT--PART

SEASON- W I N T E R

AIR QUALITY STANDARD = 0.75000E-06

RECEPTOR NUMBER	ARITHMETIC MEAN CONCENTRATION	EXCESS ABOVE AIR QUALITY STANDARD	CONTRIBUTION FROM POINT SOURCES	CONTRIBUTION FROM AREA SOURCES	NECESSARY REDUCTION FOR POINT SOURCES	NECESSARY REDUCTION FOR ALL SOURCES
14	0.47079E-05	0.39579E-05	0.21680E-05	0.25399E-05	182.55653	84.06932
9	0.37906E-05	0.30406E-05	0.24459E-05	0.13446E-05	124.30992	80.21397
19	0.33140E-05	0.25640E-05	0.57155E-06	0.27425E-05	448.60938	77.36884
8	0.33013E-05	0.25513E-05	0.17398E-05	0.15616E-05	146.64830	77.28189
15	0.27865E-05	0.20365E-05	0.73632E-06	0.20502E-05	276.58252	73.08472
13	0.26787E-05	0.19287E-05	0.11818E-05	0.14969E-05	163.20094	72.00102
20	0.25226E-05	0.17726E-05	0.45970E-06	0.20629E-05	385.59692	70.26840
10	0.21332E-05	0.13832E-05	0.84540E-06	0.12878E-05	163.61703	64.84193
18	0.17660E-05	0.10160E-05	0.46955E-06	0.12965E-05	216.38498	57.53207
4	0.14845E-05	0.73451E-06	0.70454E-06	0.77997E-06	104.25415	49.47839
12	0.14103E-05	0.66033E-06	0.43527E-06	0.97506E-06	151.70659	46.82088
7	0.13935E-05	0.64348E-06	0.51048E-06	0.88300E-06	126.05380	46.17792
24	0.13662E-05	0.61618E-06	0.27428E-06	0.10919E-05	224.65753	45.10251
25	0.13434E-05	0.59342E-06	0.27240E-06	0.10710E-05	217.84915	44.17241
3	0.12293E-05	0.47930E-06	0.50421E-06	0.72510E-06	95.06100	38.98990
5	0.12240E-05	0.47398E-06	0.50002E-06	0.72396E-06	94.79187	38.72461
23	0.11218E-05	0.37175E-06	0.24671E-06	0.87504E-06	150.68407	33.14038
17	0.11007E-05	0.35068E-06	0.31626E-06	0.78442E-06	110.88361	31.86050
2	0.94503E-06	0.19503E-06	0.37516E-06	0.56988E-06	51.98712	20.63780
6	0.91884E-06	0.16884E-06	0.25478E-06	0.66406E-06	66.26787	18.37527

TABLE 4-3 SOURCE CONTRIBUTIONS

SCURCE CCNTRIBUTIONS TO 5 RECEPTORS

POLLUTANT - SOX   SEASON - ANNUAL

SOURCE	RECEPTOR 9	RECEPTOR 10	RECEPTOR 14	RECEPTOR 8	RECEPTOR 13
1	82.59 %	21.82 %	53.20 %	83.20 %	68.66 %
2	4.16 %	2.19 %	21.19 %	4.00 %	10.94 %
3	7.35 %	68.80 %	7.38 %	3.56 %	4.76 %
4	0.02 %	0.02 %	0.02 %	0.05 %	0.06 %
5	0.20 %	0.14 %	0.28 %	0.32 %	0.55 %
6	0.94 %	0.57 %	0.96 %	4.46 %	1.86 %
7	2.07 %	1.98 %	10.99 %	2.28 %	8.20 %
8	0.79 %	0.92 %	2.28 %	0.87 %	2.78 %
9	1.63 %	3.16 %	3.03 %	1.00 %	1.59 %
10	0.25 %	0.40 %	0.66 %	0.26 %	0.59 %

4.5.2 Graphic Data Output

Three plotting options are available to the user for computer-generated contour mapping. The first is a CALCOMP[*]— generated plot of air pollution concentration iso-intensity lines, referred to as isopleths, which are superimposed on a map of the region (Figure 4-2). The second option is a line-printed, SYMAP[**]— generated plot, consisting of various shaded areas and bounded by the perimeter of the region (Figure 4-3). Each shaded area represents a different level of air pollution concentration.

---

[*] CALCOMP is a manufacturer's name for an X-Y plotter. TRW Systems is using a CALCOMP plotter and an IBM computer to generate contour maps of air pollution isopleths. The program for this operation is an IBM routine entitled "Numerical Surface Techniques and Contour Maps Plotting (1130-CX-11X)."

[**] SYMAP-Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University, Cambridge, Mass.

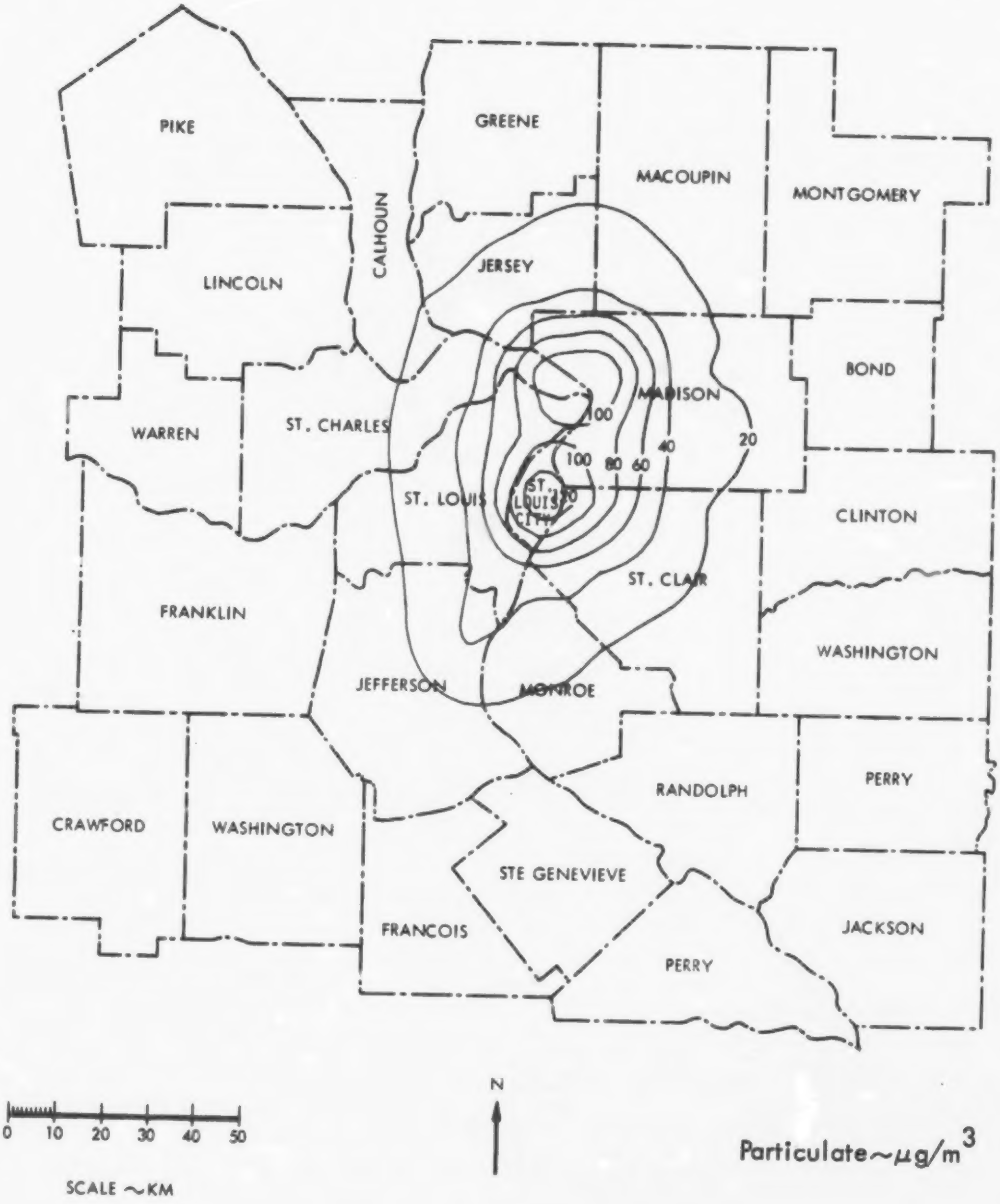
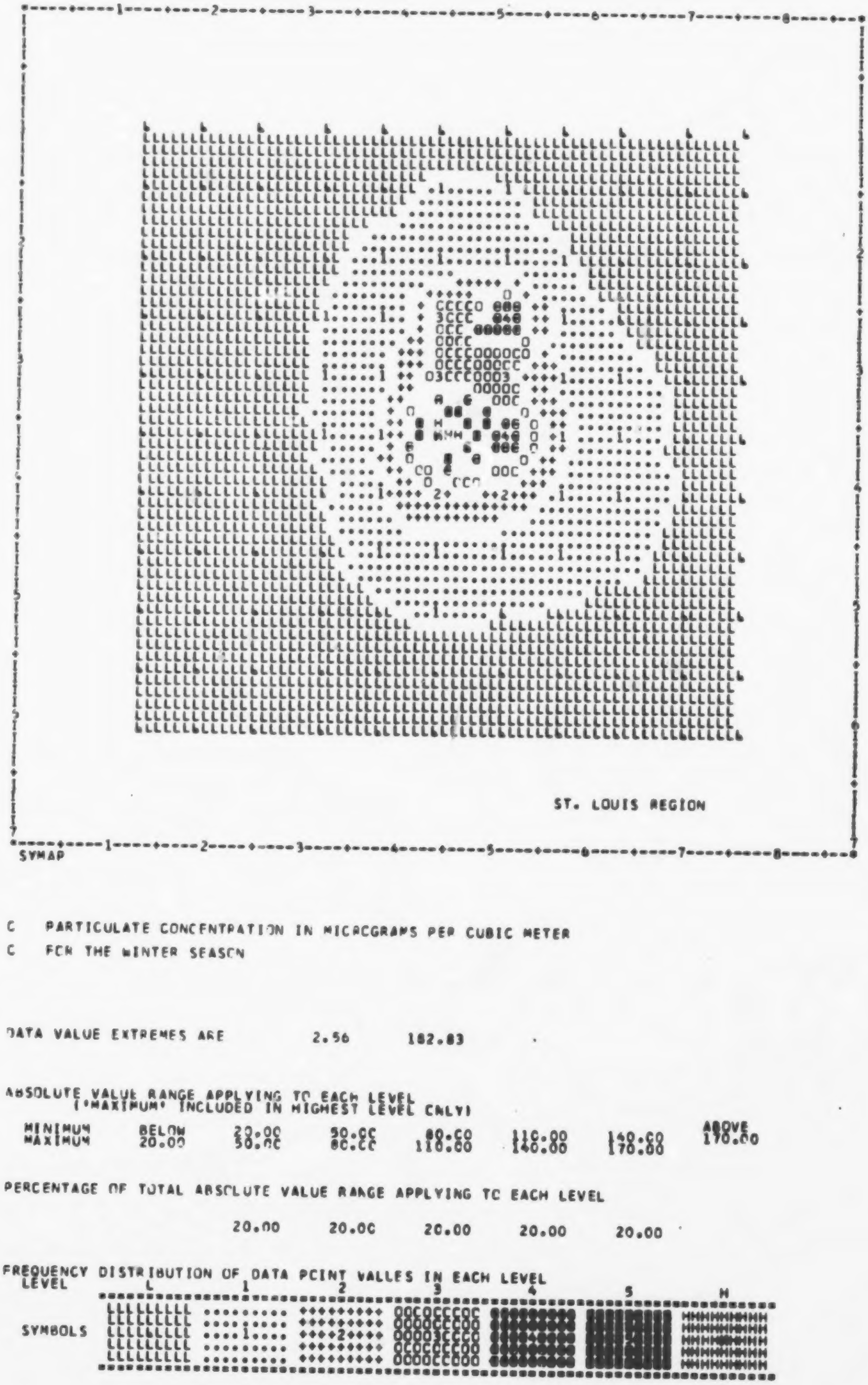

PIKE
GREENE
MACOUPIN
MONTGOMERY
CALHOUN
JERSEY
LINCOLN
BOND
MADISON
WARREN
ST. CHARLES
100
20
40
100
80
60
ST. LOUIS CITY
ST. LOUIS
CLINTON
ST. CLAIR
FRANKLIN
WASHINGTON
JEFFERSON
MONROE
RANDOLPH
PERRY
CRAWFORD
WASHINGTON
STE GENEVIEVE
FRANCOIS
PERRY
JACKSON
0
10
20
30
40
50
SCALE ~KM
N
Particulate~$\mu g/m^3$

FIGURE 4-2 Air Pollution Isopleth Contour Map Plot



```
C    PARTICULATE CONCENTRATION IN MICROGRAMS PER CUBIC METER
C    FOR THE WINTER SEASON


DATA VALUE EXTREMES ARE          2.56       182.83


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
  MINIMUM      BELOW      20.00      50.00      80.00     110.00     140.00      ABOVE
  MAXIMUM      20.00      50.00      80.00     110.00     140.00     170.00     170.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                       20.00      20.00      20.00      20.00      20.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          L          1          2          3          4          5          H

 SYMBOLS
```

FIGURE 4-3 SYMAP Contour Map Plot

4.6 REFERENCES

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5. CONTROL COST-EFFECTIVENESS MODEL

5.1 PURPOSE

The Control Cost-Effectiveness Model provides calculated cost and effectiveness values for air pollution control measures applicable to each of the sources in the region's emission inventory. In addition, these values are used as inputs to the Abatement Strategy Model (Chapter 6) to satisfy the various control strategy options and to the Regional Econometric Model (Chapter 7) to measure the regional economic impact of investments in air pollution control.

5.2 DESIGN SUMMARY

As the model hypothetically applies control measures to every source, it calculates the cost and effectiveness of the control measure and stores the results for use by other models. Effectiveness is expressed in percent reduction in the source emission rate and in the new emission rate (tons/days) due to the installation of the control measure. The annual cost ($/yr) is calculated and the cost-effectiveness ratio is determined ($/ton of reduced emissions).

The control cost and control effectiveness information contained in this model were translated into mathematical equations from two NAPCA documents:

- Control Techniques for Particulate Air Pollutants
  U.S. Department of Health, Education and Welfare; Public Health Service; Consumer Protection and Environmental Health Service, NAPCA, Washington, D.C., January 1969.

- Control Techniques for Sulfur Oxides Air Pollutants
  U.S. Department of Health, Education and Welfare; Public Health Service; Consumer Protection and Environmental Health Service, NAPCA, Washington, D.C., January 1969.

For highly advanced control measures (e.g., electrogasdynamic and magnetohydrodynamic power sources, pressurized combustion), these documents do not include cost and effectiveness information in the detail required by the model. Therefore, for these measures additional information has been prepared for the model and is discussed in Section 5.3.2.

Very limited information is available on the control of carbon monoxide emissions. When the corresponding NAPCA document on control techniques for carbon monoxide air pollutants is published, this section of the model will be expanded to include this information.

In addition to these self-contained process data, the model requires input data, provided by the user, which account for regional and national cost parameters such as sales-tax rate, prime bank-lending rates, and investment tax credits.

Both the control technique information and cost information reside in the data file. The Control Cost-Effectiveness Model computes manufacturer's price, installation costs, capital charges, total annual costs, and control efficiencies for the set of control devices and non-device control measures selected by the user or by the Abatement Strategy Model.

5.2.1 Model Operations

The model's overall operating steps are shown in Figure 5-1. Each air pollution source, such as an industrial plant or power generation

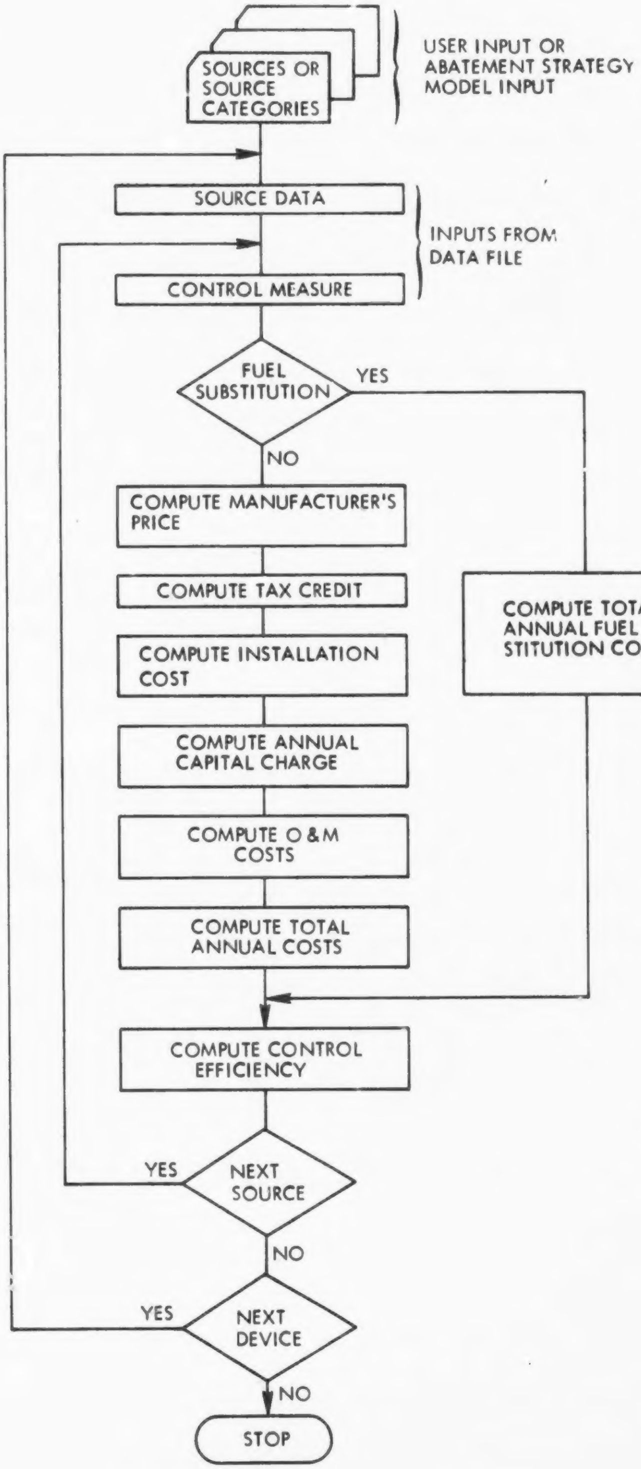
SOURCES OR SOURCE CATEGORIES
USER INPUT OR ABATEMENT STRATEGY MODEL INPUT
SOURCE DATA
INPUTS FROM DATA FILE
CONTROL MEASURE
FUEL SUBSTITUTION
YES
NO
COMPUTE MANUFACTURER'S PRICE
COMPUTE TAX CREDIT
COMPUTE INSTALLATION COST
COMPUTE ANNUAL CAPITAL CHARGE
COMPUTE O & M COSTS
COMPUTE TOTAL ANNUAL COSTS
COMPUTE TOTAL ANNUAL FUEL SUBSTITUTION COSTS
COMPUTE CONTROL EFFICIENCY
YES
NEXT SOURCE
NO
YES
NEXT DEVICE
NO
STOP

FIGURE 5-1 Cost-Effectiveness Model Operation

station, will have one or more control measures which can be applied for reducing air pollution emissions. Furthermore, each control measure will have a different cost and control efficiency depending on the source to which it is being applied. The data file will provide the Control Cost-Effectiveness Model with all the control measures applicable to the specific sources, along with some additional information about the sources themselves.

At this point, two major program loops are set up which accomplish all cost and effectiveness calculations on each source-control measure combination.

The first decision within these loops determines whether the control measure is a control device, such as a precipitator, or a non-device control measure, such as fuel substitution (or switching). This distinction is required by the detailed nature of the cost calculation. From here the model calculations proceed down parallel paths for both the device and non-device control measures. In each path the model calculates annual cost from the manufacturer's price, installation cost, annual capital charge, and operation and maintenance costs, as well as the new emissions. For each control device-source combination, the manufacturer's price is computed using equations developed to fit the curves in the Control Techniques documents. A more detailed discussion of the method used in fitting these curves will be found in Section 5.3.4.

Installation cost is determined by specific conditions at the site where the device is to be installed. These costs can be inflated if, for example, a control device must be installed between existing buildings or on a roof. These specific inputs can be chosen by the user as low, medium, high or extremely high for each of the elements which make up the installation cost. Sufficiently detailed data on these costs are available.

The total installed cost of a control device for a particular source then is computed as the manufacturer's price plus the product of the installed cost factor and manufacturer's price.

The user must determine the depreciation rate to be applied to any given control device at a source. The actual depreciation period chosen depends on the estimated life of the device as determined by its expected mean time to failure or a fixed write-off period promulgated by the Internal Revenue Service. The user may presume a more or less rapid rate of technological innovation in the area of air pollution control measures, or may utilize a regional or national allowance for fast write-off of such equipment. The interest rate, or opportunity cost of capital, also will be provided by the user for each source, when such data are available. The annual capital charge percent is computed as the sum of the depreciation and interest rates. Multiplying this factor by the total installed cost of a device results in the annual capital charge for each control device-source combination.

Total operation and maintenance costs of each control device-source combination are computed, using a slight modification of the equations found in the Control Techniques documents. The specific equations are listed in Section 5.3.4.

The Control Cost-Effectiveness Model supplies the total annual cost of a control device or non-device control measure for a particular source. This is the sum of the annual capital charge and the annual operation and maintenance cost.

The control measure efficiencies are calculated for each control device-source combination and, along with the total annual cost information for each control measure, are provided as an input to the Abatement Strategy Model or as an itemized print-out of the Control Cost-Effectiveness Model. The cost and effectiveness of control measures in future years can be determined by the user applying his estimates of the annual rate of change in these factors over an appropriate time period.

The flow chart of the model's operations is shown in Figure 5-2.

5.2.2 Model Inputs

Input data to the Control Cost-Effectiveness Model are transmitted directly from the data file. The source emission data and the control cost and effectiveness input data are described in Section 5.3.1.

All source-device combinations are coded to allow maximum utilization of the data. Control cost-effectiveness information can be selected for single air pollution sources (a power plant), industry categories (all feed and grain mills) or one or more SIC code categories (4911). Table 5-1 illustrates the code used to select specific sources or source categories for the St. Louis region. Control measures are coded in similar fashion.

The sensitivity of the Control Cost-Effectiveness Model depends on the quality of the data supplied by the user. The model provides the mechanism for detailed analysis of effectiveness and cost of installing, owning, and operating a wide variety of air pollution control measures. When the user satisfies the data base, the model generates reliable, specific outputs. Estimation of raw data elements cannot be upgraded by the program. The availability of detailed emission inventory data will undoubtedly be the major constraint on the wide use of the Control Cost-Effectiveness Model.

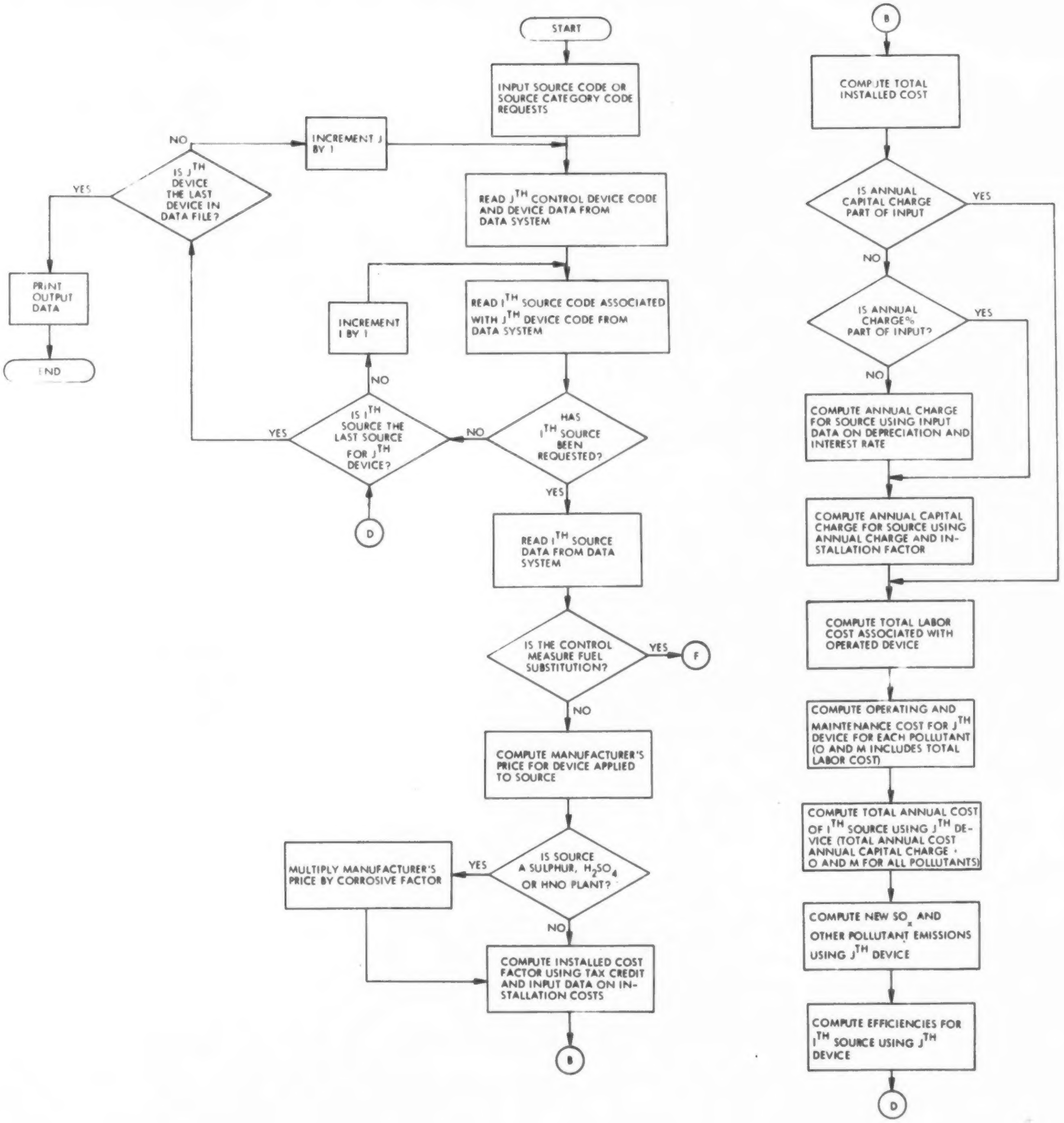
START
INPUT SOURCE CODE OR SOURCE CATEGORY CODE REQUESTS
INCREMENT J BY 1
NO
IS J^TH DEVICE THE LAST DEVICE IN DATA FILE?
YES
READ J^TH CONTROL DEVICE CODE AND DEVICE DATA FROM DATA SYSTEM
PRINT OUTPUT DATA
END
INCREMENT I BY 1
READ I^TH SOURCE CODE ASSOCIATED WITH J^TH DEVICE CODE FROM DATA SYSTEM
NO
IS I^TH SOURCE THE LAST SOURCE FOR J^TH DEVICE?
YES
NO
HAS I^TH SOURCE BEEN REQUESTED?
YES
D
READ I^TH SOURCE DATA FROM DATA SYSTEM
IS THE CONTROL MEASURE FUEL SUBSTITUTION?
YES
F
NO
COMPUTE MANUFACTURER'S PRICE FOR DEVICE APPLIED TO SOURCE
IS SOURCE A SULPHUR, H2SO4 OR HNO PLANT?
YES
MULTIPLY MANUFACTURER'S PRICE BY CORROSIVE FACTOR
NO
COMPUTE INSTALLED COST FACTOR USING TAX CREDIT AND INPUT DATA ON INSTALLATION COSTS
B
B
COMPUTE TOTAL INSTALLED COST
IS ANNUAL CAPITAL CHARGE PART OF INPUT
YES
NO
IS ANNUAL CHARGE% PART OF INPUT?
YES
NO
COMPUTE ANNUAL CHARGE FOR SOURCE USING INPUT DATA ON DEPRECIATION AND INTEREST RATE
COMPUTE ANNUAL CAPITAL CHARGE FOR SOURCE USING ANNUAL CHARGE AND INSTALLATION FACTOR
COMPUTE TOTAL LABOR COST ASSOCIATED WITH OPERATED DEVICE
COMPUTE OPERATING AND MAINTENANCE COST FOR J^TH DEVICE FOR EACH POLLUTANT (O AND M INCLUDES TOTAL LABOR COST)
COMPUTE TOTAL ANNUAL COST OF I^TH SOURCE USING J^TH DEVICE (TOTAL ANNUAL COST = ANNUAL CAPITAL CHARGE + O AND M FOR ALL POLLUTANTS)
COMPUTE NEW SOx AND OTHER POLLUTANT EMISSIONS USING J^TH DEVICE
COMPUTE EFFICIENCIES FOR I^TH SOURCE USING J^TH DEVICE
D

FIGURE 5-2 Control Cost-Effectiveness Model Flow Chart

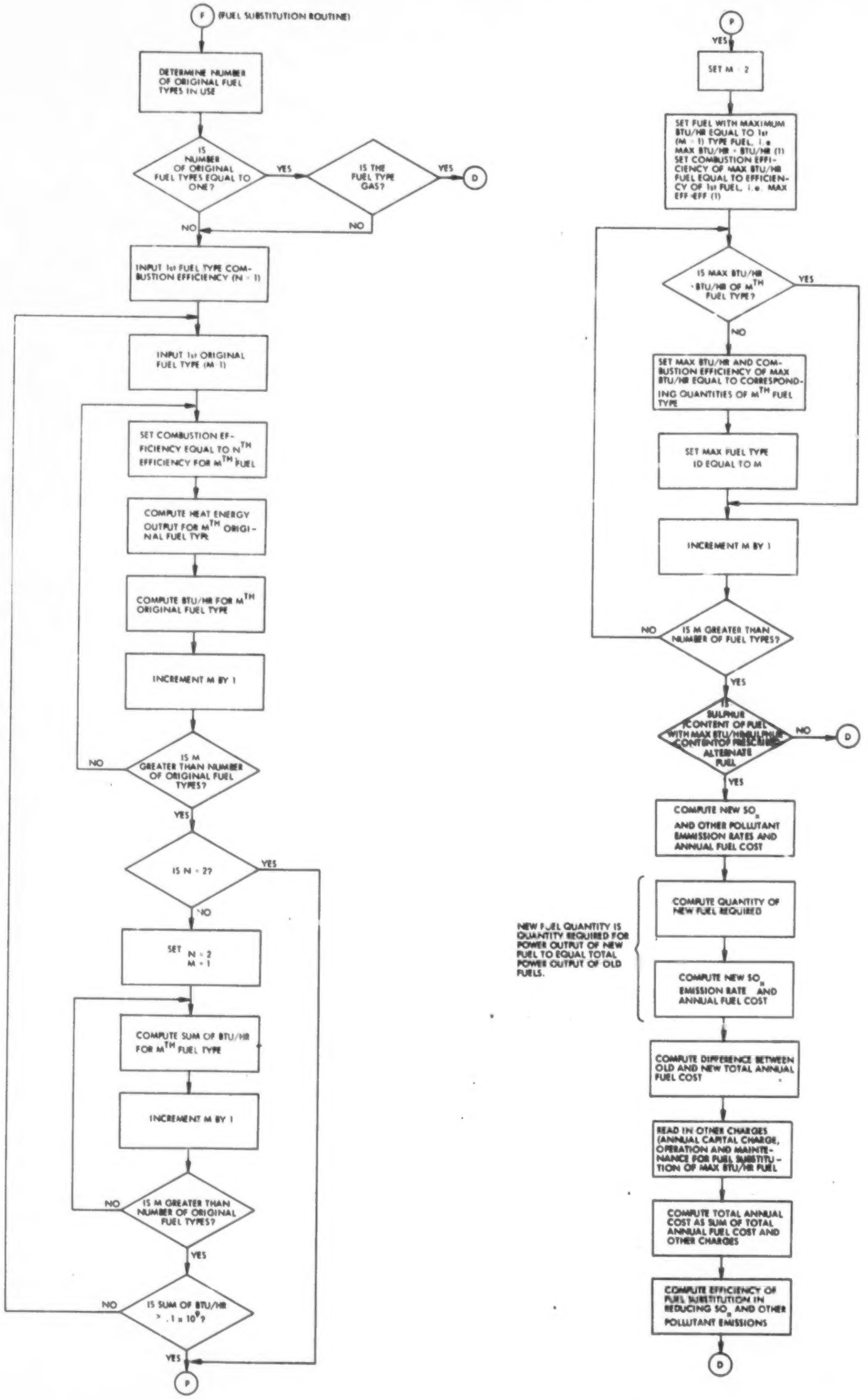
F
(FUEL SUBSTITUTION ROUTINE)
DETERMINE NUMBER OF ORIGINAL FUEL TYPES IN USE
IS NUMBER OF ORIGINAL FUEL TYPES EQUAL TO ONE?
YES
IS THE FUEL TYPE GAS?
YES
D
NO
NO
INPUT 1st FUEL TYPE COMBUSTION EFFICIENCY (N = 1)
INPUT 1st ORIGINAL FUEL TYPE (M = 1)
SET COMBUSTION EFFICIENCY EQUAL TO NTH EFFICIENCY FOR MTH FUEL
COMPUTE HEAT ENERGY OUTPUT FOR MTH ORIGINAL FUEL TYPE
COMPUTE BTU/HR FOR MTH ORIGINAL FUEL TYPE
INCREMENT M BY 1
NO
IS M GREATER THAN NUMBER OF ORIGINAL FUEL TYPES?
YES
IS N = 2?
YES
NO
SET N = 2 M = 1
COMPUTE SUM OF BTU/HR FOR MTH FUEL TYPE
INCREMENT M BY 1
NO
IS M GREATER THAN NUMBER OF ORIGINAL FUEL TYPES?
YES
NO
IS SUM OF BTU/HR > .1 x 10^9?
YES
P
P
YES
SET M = 2
SET FUEL WITH MAXIMUM BTU/HR EQUAL TO 1st (M = 1) TYPE FUEL, i.e MAX BTU/HR = BTU/HR (1) SET COMBUSTION EFFICIENCY OF MAX BTU/HR FUEL EQUAL TO EFFICIENCY OF 1st FUEL, i.e. MAX EFF=EFF (1)
IS MAX BTU/HR = BTU/HR OF MTH FUEL TYPE?
YES
NO
SET MAX BTU/HR AND COMBUSTION EFFICIENCY OF MAX BTU/HR EQUAL TO CORRESPONDING QUANTITIES OF MTH FUEL TYPE
SET MAX FUEL TYPE ID EQUAL TO M
INCREMENT M BY 1
NO
IS M GREATER THAN NUMBER OF FUEL TYPES?
YES
IS SULPHUR CONTENT OF FUEL WITH MAX BTU/HR SULPHUR CONTENT OF PRESCRIBED ALTERNATE FUEL
NO
D
YES
COMPUTE NEW SO_x AND OTHER POLLUTANT EMMISSION RATES AND ANNUAL FUEL COST
NEW FUEL QUANTITY IS QUANTITY REQUIRED FOR POWER OUTPUT OF NEW FUEL TO EQUAL TOTAL POWER OUTPUT OF OLD FUELS.
COMPUTE QUANTITY OF NEW FUEL REQUIRED
COMPUTE NEW SO_x EMISSION RATE AND ANNUAL FUEL COST
COMPUTE DIFFERENCE BETWEEN OLD AND NEW TOTAL ANNUAL FUEL COST
READ IN OTHER CHARGES (ANNUAL CAPITAL CHARGE, OPERATION AND MAINTENANCE FOR FUEL SUBSTITUTION OF MAX BTU/HR FUEL
COMPUTE TOTAL ANNUAL COST AS SUM OF TOTAL ANNUAL FUEL COST AND OTHER CHARGES
COMPUTE EFFICIENCY OF FUEL SUBSTITUTION IN REDUCING SO_x AND OTHER POLLUTANT EMISSIONS
D

FIGURE 5-2. Control Cost-Effectiveness Model Flow Chart (Continued)

TABLE 5-1. SOURCE CODE LIST FOR ST. LOUIS POINT SOURCES

INDUSTRY	GRID NO.**	SIC CODE	RAPA SOURCE CODE
Power Generation			
1	61	4911	01
2	34	4911	02
3	34	4911	03
4	38	4911	04
5	6	4911	05
6	25	4911	06
7	54	4911	07
Feed & Grain			
1	24	2040	10
2	28	2040	11
3	34	2040	12
4	34	2040	13
5	37	2040	14
6	38	2040	15
7	43	2040	16
8	43	2040	17
9	60	2040	18
10	70	2040	19
		2040	
Commercial Est			
1	26	9900	20
2	32	9900	21
3	37	9900	22
4	41	9900	23
5	76	9900	24
6	58	9900	25
		9900	
Sulfuric Acid Plants			
1	68	2819	30
2	71	2819	31
3	38	2819	32
4	44	2818	33
5	76	2819	34
Chemical Plants			
1	5	2800	40
2	34	2800	41
3	30	2800	42
4	70	2800	43
Rock, Sand & Gravel			
1	17	3295	50
2	7	3295	51
3	7	3295	52
4	76	3295	53
Petroleum Refining			
1	5	2911	60
2	5	2911	61
3	24	2911	62
4	45	2911	63
Steel Foundries			
1	23	3323	70
2	29	3323	71
3	29	3323	72
Breweries			
1	43	2082	80
2	43	2082	81
3	50	2082	82
Meat Processing			
1	33	2010	90
2	35	2010	91
3	36	2010	92
Cement Mfg			
1	13	3241	100
2	76	3241	101
Steel Mills			
1	61	3312	110
2	29	3312	111
Glass Mfg			
1	39	3210	120
2	54	3210	121
Incineration			
1	28	4953	130
2	43	4953	131
Mineral Products			
1	29	3200	140
Asphalt Batching			
1	74	2951	150
Nitric Acid Plant			
1	54	2819	160
Paint			
1	74	2851	170
Misc Mfg			
1	18	3900	180
Rubber Plant			
1	44	2822	190
Dairy			
1	41	2020	200
Ceramic & Clay			
1	17	3250	210
Starch Mfg			
1	23	2046	220
Soap Mfg			
1	27	2841	230
Railroad Car Mfg.			
1	21	3742	240
Auto Mfg			
1	26	3711	250
2	74	3711	251
Fertilizer Plant			
1	35	2819	260
Lead Smelting			
1	54	3332	270

NOTES

** Grid No's. correspond to St. Louis Emission Inventory Data.

TABLE 5-1. (Continued)

SOURCE CODE SELECTION

COL.*	DATA	USE
1-4	SIC#	If SIC# is present only sources in this SIC Group will be processed.
5-8	Beginning Site #	This number indicates the first source of the SIC Group to be processed.
9-12	Ending Site #	This number indicates the last source of the SIC Group to be processed.
13	Source Type	If Cols. 1-12 are blank, type indicates 0 - do all sources 1 - do combustion sources only 2 - use previous input sources for the new strategy on this card. When columns 1-12 are not blank, ignore this field.

---

[*] The column numbers refer to a punched control card which makes up a source code message and thereby permits the user to specify any particular source or source grouping for the Control Cost-Effectiveness Model.

5.2.3 Model Outputs

The results of the Control Cost-Effectiveness Model computations can be used in a variety of ways. The output can print out a display set of alternative control measures available to any single emission source along with the annual cost and efficiency of each control measure. By aggregation of the results, a similar display can be constructed for groupings of sources; for instance, by four digit SIC code.

A sample output is shown in Table 5-2 for a specific SIC code and site number. The output information contains the applicable control measures, annual costs, as well as controlled versus uncontrolled emissions. This information can be used as an input to the Regional Econometric Model and the Abatement Strategy Model, or simply as the results of separate cost-effectiveness analyses.

5.3 MODEL STRUCTURE

The Control Cost-Effectiveness Model structure is in two segments - control devices and fuel substitution. These two major program loops are necessary because the cost calculations are substantially different. In both cases, the output is device effectiveness (new emissions compared to original emissions) and annual cost of the control measure.

5.3.1 Input Data Definitions

Detailed EMISSION INVENTORY (Table 5-3) and CONTROL COST-EFFECTIVENESS (Table 5-4) data are required to form the data base for the model. These tables are shown in the following pages. The alphabetical identifiers in these tables are used in the cost calculations, Sections 5.3.3 and 5.3.4.

```
                                      CCNTROL COST-EFFECTIVENESS REPCRT*

              SIC=  2020     SITE=  2CCO           ORIGINAL EMISSIONS
                                                  SOX      CO        PART
                                                 1.350     0.0       1.730
                                                -------------------------------

** DEVICE    EFFICIENCIES            COST        CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
           SOX      CO     PART      DCLLARS      SOX      CO        PART       SOX       CO        PART

      7    0.0      0.0    0.850     6861.56     1.350     0.0       0.259      0.C       0.0       12.78
      8    0.0      0.C    0.70C     6C78.61     1.350     0.0       0.519      0.0       0.0       13.75
      9    0.0      0.0    0.600     5143.55     1.350     0.0       0.692      0.C       0.0       13.58
     10    0.0      0.0    0.980    22381.45     1.350     0.0       0.035      0.0       0.0       36.17
     11    0.0      0.0    0.950    18616.09     1.350     0.0       0.086      0.0       0.0       31.03
     12    0.0      0.0    0.900    14974.14     1.350     0.0       0.173      0.0       0.0       26.35
     27    0.303    0.0    0.381    2C008.98     0.941     0.0       1.070    133.94      0.0       83.07
     28    0.652    0.0    0.381    28593.04     0.470     0.0       1.070     89.C6      0.0      118.70
     29    0.838    0.0    0.424    38257.48     0.219     0.0       0.996     92.67      0.0      142.85
     30    0.879    0.0    0.979    41814.92     0.163     0.0       0.037     96.49      0.0       67.65
     31    C.940    0.0    0.979    4523C.86     0.081     0.0       0.037     97.68      0.0       73.18
     32    0.970    0.0    0.979    52062.73     0.041     0.0       0.037    108.94      0.0       84.23
     33    1.000    0.0    0.997    62258.61     0.0       0.0       0.005    126.35      0.0       98.90
```

* A complete report is contained in the Appendix.

** Table 5-5 contains the control device code designations.

Table 5-2 Control Cost-Effectiveness Model Output

TABLE 5-3

EMISSION INVENTORY DATA

A. Source ID is an eight-digit number assigned to each source in the region. The first four digits are the SIC code. The next three digits are a site code which the user develops for the region. The last digit identifies a combustion source (0) or a process source (1-9) at the site.

B. Location is noted as an x-y coordinate on any of a number of user-selected rectilinear grid systems. The Universal Transverse Mercator system or an arbitrary system with its 0-0 point outside the region's southwest corner could be used. The units can be either miles or kilometers. In the case of a point source, the location is a point; for an area source, the centroid of the area; and for a line source, location defines one end of the line.

C. Area applies only to area sources, expressed in square miles or square kilometers.

D. Line is the x-y location of the other end of the line source from the point noted in Location.

E. Ownership is classified as utility, federal, state, county, municipality or private.

F. Sulfur Content is the percent sulfur in the fuel or process material.

G. Process Units are weight units (e.g., tons, miles, cubic feet, bushels, gallons, etc.) necessary to define the process.

H. Process Type, e.g., furnace, incinerator, manufacturing, or transportation, describes the process.

I. Stack Height is the height of the stack above grade.

J. Stack Diameter is the diameter of the stack at the exit.

K. Exit Velocity is the velocity of the gas leaving the stack.

L. Exhaust Temperature is the temperature of the gas leaving the stack.

M. Ambient Temperature is the average temperature in the region for summer, winter, and annual conditions.

TABLE 5-3

EMISSION INVENTORY DATA (Continued)

N. Ambient Pressure is the average barometric pressure in the region for summer, winter and annual conditions.

O. Diurnal Variations refer to the number of shifts per day the process operates. This is noted for summer, winter and annual conditions.

P. Existing Control is a coded identification of air pollution control measures which are currently in effect at the site. These are detailed in Section 5.3.2.

Q. Control Efficiency is the efficiency of the control measure currently in effect at the site for each pollutant.

R. Process Rate is the weight of solid materials processed per day in Process Units. This is entered for summer, winter and annual average conditions.

S. Process Projections can be entered if it is known that the process rate will change in the future.

T. Emission Factors are the relationship between process rate and emission potential for each pollutant.

U. Emission Inventory is the actual emission of pollutants from the source with the existing control measures in effect. It is calculated by the program if the above data are supplied. If the inventory for each pollutant is known, it can be entered directly.

TABLE 5-4

CONTROL COST-EFFECTIVENESS DATA

A. Control Measure ID is a coded identification of the air pollution control measure to be applied to the source. These are detailed in Section 5.3.2.

B. Efficiency is the efficiency of the new control measure on each of the pollutants, applied against the current emissions filed in the emissions inventory (%).

C. Source ID is the same as described in Table 5-3.

D. Capacity is the actual gas volume to be processed by the new control measure (ACFM).

E. Gas Temperature is the temperature of the gas at the point where the new control measure will be installed (°F).

F. Corrosive Factor applies only for special situations (such as acid plants) where special materials of construction will be required for control equipment (dimensionless).

G. Manufacturer's Price is the initial investment cost for the control equipment, without installation costs ($).

H. Sales Tax is that levied on the control equipment by local jurisdictions (% of G).

I. Tax Credit is a savings from applicable federal investment tax credits or state and local tax credits, for the installation of control equipment (% of G).

J. Transportation Cost is the cost of delivery of the control equipment from the point of manufacture to the site (% of G).

K. Erection Cost is the cost of erecting the equipment at the site (% of G).

L. A&E Fee is the architectural and engineering cost for the installation (% of G).

M. Auxiliary Equipment is the cost of fans, ductwork, controls and other equipment required for the system (% of G).

N. Utility Connection is the cost of providing utilities at the site (% of G).

O. Startup costs include materials, labor and loss of production associated with bringing the new control measure on line (% of G).

TABLE 5-4

CONTROL COST-EFFECTIVENESS DATA (Continued)

P. Spare Parts are those included as capital equipment (% of G).

Q. Land and Buildings necessary for installation of the control measure are part of the capital cost (% of G).

R. Installed Cost is computed from items G through Q ($).

S. Life is the number of years over which the equipment is depreciated (yrs).

T. Depreciation is the reciprocal of the life (%).

U. Interest Rate on borrowed capital or the opportunity cost of equity capital is a charge against the installation (%).

V. Annual Charge is the percentage sum of all charges against capital (%).

W. Annual Capital Cost is the cost in dollars of owing the control measure ($/yr).

AA. Pressure Drop is measured across the control device (in H_2O).

BB. Operating Time for the control measure (hrs/yr).

CC. Electricity Cost is the rate which the owner pays for electricity used by the control measure ($/KwHr).

DD. Liquor or Catalyst Use is the makeup or replacement rate (units/hr).

EE. Liquor or Catalyst Cost is in dollars per use-unit.

FF. Quantity of Pollutant is the amount of pollutant collected by the control device (tons/day).

GG. Cost or Credit of Disposal of the collected pollutant can be a charge for disposal or a credit for sale of the pollutant ($/ton).

HH. Electricity is the total amount of electricity required to operate the control measure, including fan horsepower (KwHr).

II. Fuel Cost is the cost of fuel used for an afterburner type control device ($/unit).

JJ. Fuel Quantity is that used by an afterburner type control device (units/hr).

KK. Labor is the annual hours of labor, by type, required for operation and maintenance of the control measure (hrs/yr).

TABLE 5-4

CONTROL COST-EFFECTIVENESS DATA (Continued)

LL. Labor Cost is the salary, by type, for the labor ($/hr).

MM. Working Capital is that money required for the installation ($/yr).

NN. Total O&M Cost is computed from items AA through MM, or it can be an input ($/yr).

OO. Combustion Efficiency applies to the existing fuel at a combustion source (%).

PP. Cost is the cost of the original fuel ($/unit).

QQ. Quantity of the original fuel (units/yr).

RR. Heat Content of the original fuel (BTU/unit).

SS. Heat Energy Output of the combustion source with the original fuel. In a fuel substitution this is held constant (BTU/yr).

TT. Heat Content of the alternate fuel (BTU/unit).

UU. Cost of the alternate fuel ($/unit).

VV. Combustion Efficiency of the alternate fuel (%).

WW. Substitution in Effect as percent of operating time (%).

XX. Total Annual Cost is the total cost of owning and operating the control measure ($/yr).

YY. Projected Annual Cost is an anticipated rate of change in the annual cost of the control measure (%/yr).

ZZ. Projected Efficiency is an anticipated rate of change in the performance of the control measure (%/yr).

5.3.2 Control Measure Definitions

The following is a description of the control devices or non-device control measures which are included in the Control Cost-Effectiveness Model. A list of these devices and their code numbers is found in Table 5-5. For the user's convenience, the more familiar "Chicago Code" [Loquercio, 1967] system for air pollution control devices may be used as the input code. If this option is chosen, the data file will automatically re-define the coding scheme for internal computation purposes. The correspondence between the device names used in the Chicago Code system and those in the Control Techniques documents is also shown in Table 5-5.

Particulate Control Devices

(a) Wet Scrubbers or Wet Collectors are devices which use a liquid, commonly water, to either remove particulates or gases directly from a gas stream by contact, or to increase the collection efficiency of a second-stage collector by increasing the effective particle diameter. The simplest wet scrubber is composed of a spray chamber into which water is injected by a spray nozzle device. Wet scrubbers applied to a hot gas stream have the additional advantage of gas cooling and humidification.

(b) Mechanical Collectors are devices which remove particulate matter from a gas stream by using only the force of gravity or centrifugal force. Nothing is injected into the gas to combine with or to entrain the particles. The two principal types of mechanical collectors are:

- Gravity Collectors which are chambers where the gas flow is slowed down sufficiently for large particles to settle out. Gravity collectors are typically very low in efficiency except for relatively large particles, and they require considerable space.

- Centrifugal Collectors or Cyclones which use the centrifugal force created by a spinning gas stream to drive particulate matter from the gas. The spinning gas stream is set up inside a cylindrical container by tangential gas inlets, vanes, or fan action.

TABLE 5-5 CONTROL MEASURE CLASSIFICATION CODE

RAPA DEVICE NAME[1]	NAPCA DEVICE NAME[2]	CHICAGO CODE	RAPA CODE
WET COLLECTORS			
High Efficiency	Wet Dynamic Precipitator Venturi Scrubber	43 44	01
Medium Efficiency	Wet Cyclone - Rotoclone	42	02
Low Efficiency	Spray Chamber With Baffles Spray Chamber - No Baffles Spray Tower	41 40	03
MECHANICAL COLLECTORS			
Gravity Collectors			
High Efficiency Medium Efficiency Low Efficiency	Settling Chamber	32	04 05 06
Centrifugal Collectors			
High Efficiency	High Efficiency Cyclone Dry Collector (Dynamic)	31 36	07
Medium Efficiency	Simple Cyclone	30	08
Low Efficiency	Simple Cyclone	30	09
ELECTROSTATIC PRECIPITATORS			
High Voltage			
High Efficiency	Electrostatic Precipitator-Double Stage	51	10
Medium Efficiency	Electrostatic Precipitator-Single Stage	50	11
Low Efficiency	High Voltage-Low Efficiency Precipitator	53	12
Low Voltage			
High Efficiency	Low Voltage-High Efficiency Precipitator	54	13
Medium Efficiency	Low Voltage-Medium Efficiency Precipitator	55	14
Low Efficiency	Low Voltage-Low Efficiency Precipitator	56	15
FABRIC FILTERS			
Type "A"	High Temperature (continuous)	34 35	16
Type "B"	Medium Temperature (continuous)	37	17
Type "C"	Low Temperature (intermittent)	33	18
INCREASED COMBUSTION EFFICIENCY			
Catalytic Combustion	Catalytic Combustion	01	19
Catalytic Combustion With Heat Exchange	Catalytic Combustion With Heat Exchange[3]	07[3]	20
Direct Flame Combustion	Direct Flame Combustion (Afterburner)	06	21
Direct Flame Combustion With Heat Exchange	Direct Flame Combustion with Heat Exchange[3]	08[3]	22
1-Step Pressurized Combustion	1-Step Pressurized Combustion[3]	96[3]	23
2-Step Pressurized Combustion	2-Step Pressurized Combustion[3]	97[3]	24
Magneto Hydro Dynamics	Magneto Hydro Dynamics[3]	98[3]	25
Electro Gas Dynamics	Electro Gas Dynamics[3]	99[3]	26

TABLE 5-5 (CONT'D) CONTROL MEASURE CLASSIFICATION CODE

RAPA DEVICE NAME	NAPCA DEVICE NAME	CHICAGO CODE	RAPA CODE
FUEL SUBSTITUTION			
High Sulfur Coal to Low Sulfur Coal	High Sulfur Coal to Low Sulfur Coal		
2% Sulfur Coal	2% Sulfur Coal[3]	81a[3]	27
1% Sulfur Coal	1% Sulfur Coal[3]	81b[3]	28
1/2% Sulphur Coal	1/2% Sulphur Coal[3]	81c[3]	29
Coal To Oil	Coal to Oil		
2% Sulfur Oil	2% Sulfur Oil[3]	82a[3]	30
1% Sulfur Oil	1% Sulfur Oil[3]	82b[3]	31
1/2% Sulfur Oil	1/2% Sulfur Oil[3]	82c[3]	32
Coal to Gas	Coal to Gas[3]	83[3]	33
Oil to Gas	Oil to Gas[3]	84[3]	34
Oil to Coal	Oil to Coal		
2% Coal	2% Coal[3]	3	35
1% Coal	1% Coal[3]	3	36
1/2% Coal	1/2% Coal[3]	3	37
FUEL DESULFURIZATION			
Coal Scrubber	Coal Desulfurization[3]	85[3]	38
Oil Desulfurization	Oil Desulfurization[3]	86[3]	39
FLUE GAS DESULFURIZATION			
Alkalized Alumina	Alkalized Alumina[3]	101[3]	40
Limestone Injection - Dry Process	Limestone Injection - Dry Process[3]	102[3]	41
Limestone Injection - Wet Process	Limestone Injection - Wet Process[3]	103[3]	42
BY-PRODUCT MANUFACTURE			
Sulfuric Acid Plant-Contact Process	Sulfuric Acid Plant - Contact Process[3]	111[3]	43
Sulfuric Acid Plant-Double Contact Process	Sulfuric Acid Plant - Double Contact Process[3]	112[3]	44
Sulfur Plant	Sulfur Plant[3]	113[3]	45
OTHER MEASURES			
Auto Engine Modification	Auto Engine Modification[3]	94[3]	46
Auto Exhaust Control Device	Auto Emission Device[3]	93[3]	47
Tall Stacks	Tall Stacks[3]	92[3]	48
CO Boiler	Boiler Firebox	03	49

---

[1] Names are those listed in Control Techniques for Sulfur Oxides and Particulate Pollutants. (Reference Section 5.2)

[2] Air Pollution Manual of Coding. (Reference Section 5.4)

[3] These devices or control measures were not listed in the "Chicago Code" list, but were added by TRW to conform with the format.

(c) Electrostatic Precipitators are devices which remove particles from a gas stream by electrically charging the suspended particles as the gas passes through an arc and collecting the charged particles on a grounded collection plate. High-voltage precipitators can be operated over a relatively wide range of collection efficiencies; low-voltage precipitators are used for small commercial sources and are used mainly for liquid particles.

(d) Fabric Filters remove particles from a gas stream by passing the gas through fabric tubes or envelopes. A cake of collected particles, supported by the fabric, accomplishes the filtration. Very high efficiencies can be attained using fabric filters. A wide range of fabrics and cleaning techniques is available.

(e) Afterburners are devices which remove both gaseous and particulate pollutants by combustion. The direct-flame afterburner brings the gas stream into contact with a high temperature flame to achieve rapid oxidation. The catalytic afterburner operates at a lower temperature by oxidizing the gas stream on the surface of a catalyst.

Sulfur Oxides Control Measures

(a) Flue Gas Desulfurization methods rely upon injection into the exit gas stream of various chemicals which either react with sulfur oxide directly to produce a readily collectible solid or absorb the sulfur oxide by producing a physically bonded sulfate. The more promising methods for cleaning flue gases are:

- The Alkalized Alumina Process which employs activated sodium aluminate to react with the sulfur oxide to produce sodium sulfate. The sodium aluminate is regenerated in the process by heating in the presence of reducing gases. This regeneration process produces hydrogen sulfide, which then is converted to elemental sulfur by a conventional Claus-type reaction.

  Due to the lack of data from larger size prototype units, economic data for this process are very speculative at this time and must be based on the Bureau of Mines estimates [McCrea, 1968; Katell, 1967]. Their estimate covers only an 800 MW size coal-fired plant and indicates approximately 90% removal of sulfur oxides. However, the alkalized alumina process is not applicable to older existing plants because of the many changes which must be made to the flue gas duct and heat recovery systems. Large new plants constructed during the early to middle 1970's will be prime candidates for this system when it is perfected.

- The Limestone Injection - Dry Process which employs finely ground limestone injected into the boiler combustion zone to form calcium sulfate. The sulfate then is removed from the gas stream by a precipitator or other particulate control device.

- The Limestone Injection - Wet Process which employs the same basic injection of limestone as the dry process, but instead of collecting calcium sulfate in the dry state, a liquid slurry of lime is used to remove the sulfate and any unreacted sulfur oxide.

(b) Combustion Process Modifications are designed to reduce the source emission of sulfur oxides by increasing the combustion efficiency so that less fuel is required to produce the same heat output. These processes are largely in the developmental stages, and therefore will apply to future construction projects. The most promising designs for improved combustion efficiency include:

- Pressurized Combustion systems which offer the advantage of recovering energy by passing the hot, compressed gases through a gas turbine to obtain an additional energy output. There are a variety of pressurized combustion systems; each offers a slight increase in overall efficiency compared to the conventional steam plant. In a single-step pressurized combustion system, the furnace operates at approximately 7 atmospheres pressure. Heat from the resulting flue gas is extracted by the boiler section; the flue gases then are cleaned before being expanded through a final turbine.

  Capital costs for this system are about $120/KW for a 500-MW size plant with an expected decrease in the heat rate of 5% [Perry, 1968]. This is equivalent to an overall generating efficiency of 41%.

  In the two-stage combustion process, the first stage is essentially a gasification step followed by gas cleaning including sulfur removal; this is followed by secondary combustion and expansion through a gas turbine. A capital cost of $135/KW has been estimated for a 500-MW plant [Squires, 1967].

  Pressurized combustion processes offer the potential of reduced nitrogen oxide emissions through the use of pure oxygen instead of air for combustion. Use of oxygen also would allow a considerable reduction in plant size.

- Magnetohydrodynamic Generation of Electricity - MHD is a process in which electricity is generated directly by the interaction of a hot, moving flue gas stream with a magnetic field. This process is currently in the large pilot plant stage, on the order of 10-20 MW, but these plants have not operated for sustained periods of time. Due to the high temperatures involved, operations have been limited to only a few minutes at any one time.

In order to increase overall thermal efficiency, the MHD system will probably be combined with a conventional steam-generating plant; to generate the hot flue gas stream, a fossil fuel--probably gas--is burned with heated air. Coal is a preferred fuel, since the resulting fly ash particles increase the conductivity of the gas stream. To further increase this conductivity, the hot gas is "seeded" with an alkali metal powder such as cesium or sodium salts. The seeded gas stream, at a temperature of 4300-4500°F then passes through a strong magnetic field, creating an electrical current which can be drawn from the duct surface [Young, 1967].

It is this portion of the process which is causing operational problems, namely containing a 4500°F gas stream, and producing a reasonably priced large superconducting magnet capable of creating a sufficiently strong magnetic field.

After passing through the magnetic field, the gas stream will probably pass through a heat recovery system in which steam is generated, and through a dust collection system to recover the seed.

Expected efficiency of the MHD system, that is, KW hours output versus BTU input, is in the 50-55% range. This compares to a modern steam-generating electrical power system efficiency of about 39%. Thus, less fuel is required to produce a given amount of electricity, and therefore less SO_2 and particulate matter are generated. However, nitrogen oxide emission probably will be greater than those emitted from a conventional plant because of the higher temperatures produced in the process.

- Electrogasdynamic Generation of Electricity - In the EGD system the kinetic energy of a moving gas stream is converted to electricity by using the gas stream as an electrical charge carrier. In this system the fly ash particles in a combustion gas stream are charged by passing through a corona discharge system. The charged particles are forced to the collection electrode system by the carrier gas, where the charges are removed by collector electrodes, and then caused to flow through an external load. Current is forced through the external load resistance by the gas.

The gas need not be extremely hot or conductive in this case, but it must have an abundance of charged particles in order to generate electricity. The system currently planned would compress combustion air to about 15-30 atmospheres and seed it with fly ash particles. This air then is mixed with pulverized coal and burned in a combustion chamber. The resulting flue gas, at a temperature of 1000-2000°F and heavily laden with particulate matter, is then passed to the EGD generator. No provisions currently are planned for recovering the heat generated in the combustion process, but steam easily could be generated by including a waste heat boiler system.

A large-scale EGD plant is planned for operation by 1975. Costs are speculative at this time. Installed cost for a 500 MW basic EGD plant with no heat recovery is estimated at $91/KW [Gourdine, 1966]. A conversion efficiency (fuel to electricity) of 45-50% is hoped for by 1975. Operating costs, as reported by the developer, were identical to those of a conventional steam plant, namely 0.41 mills/KW-hr excluding fuel cost.

(c) Fuel Desulfurization processes operate directly to reduce the sulfur content of the two common fuels used by power plants before combustion takes place.

- Coal Cleaning processes (coal scrubbers) involve the separation of physically combined iron pyrites from finely ground coal by exploiting the different specific gravities of coal and pyrites. The organic sulfur content of the coal is unaffected by this process, but some overall sulfur content improvement is gained.
- Oil Desulfurization is accomplished in a wide variety of ways ranging from refinery process improvements which remove the sulfur from the more common oils to a simple blending technique in which high-sulfur oils are combined with sufficiently low-sulfur oil to meet specifications.

(d) Fuel Substitution control measures involve switching from a high-sulfur content fuel to one with a lower sulfur content. The Control Cost-Effectiveness Model examines the costs of switching from coal or oil to coal, oil or gas of varying sulfur contents.

(e) By-Product Manufacturing facilities co-located with the emission source can use a sulfur-bearing gas stream to control sulfur oxide emission. Either elemental sulfur or sulfuric acid may be manufactured from a sulfur-oxide-rich gas. Both products are in relatively high demand in industrial markets, and often can bring a price high enough to substantially offset the cost of controlling emissions. Cases which considered sulfuric acid and sulfur plants as control measures are not to be confused with cases where similar plants are operated independently in such a manner as to be emission sources themselves. Clearly, a sulfur plant will not be considered a control measure for a sulfur plant emission source.

(f) Tall Stacks as a control measure do not influence the annual quantity of emissions. The use of tall stacks is considered nevertheless a control measure since the increased dispersion of pollutants achieved through their use has the potential of lowering ground-level concentrations.

Carbon Monoxide Control Devices

(a) Auto Exhaust Carbon Monoxide Control Devices are currently the subject of much research and are still largely in the developmental stage. In view of the fairly limited and sketchy information available in this area, the model will examine only exhaust emission control devices which operate on the same principle as the catalytic afterburner, and engine design modifications which result in more complete combustion of fuel.

(b) Carbon Monoxide Boiler In certain industrial processes carbon monoxide is produced in sufficient quantities and at sufficiently large concentrations to be used as a fuel source. The heat energy obtained from the combustion of CO to CO_2 is utilized to produce steam in a CO boiler. A 95% or greater reduction in the amount of CO emitted to the atmosphere is possible with this control technique.

Multiple Control Devices

The emission inventory information called upon by the Control Cost-Effectiveness Model may indicate existing control devices on sources of air pollution (Item P, Table 5-3). The annual cost of these devices is not considered. However, the device type is noted in determining whether additional control measures are compatible with the existing control device.

The efficiency of the new control device will be influenced by the existing device, so specific source-device efficiency data are required as a user input. Cost data and effectiveness are computed as for single control measures. The effectiveness is the decrease in emissions above and beyond the already partially controlled emissions.

5.3.3 Cost Definitions

The various cost elements and operating characteristics that make up the total annual control cost of a control measure are shown in Table 5-4 and defined as follows:

Installed Costs

(a) Manufacturer's List Price at point of origin is the average quoted price for the type of equipment under consideration and includes some allocated portion of any R&D incurred by the manufacturer in designing the system. This is the base cost against which the following additional costs are applied:

(b) Transportation Costs are incurred in shipping the equipment from its point of manufacture to the installation site, and include any necessary warehousing costs incurred in the transport process.

(c) Site Preparation and Installation Costs include all engineering and architectural fees resulting from the installation of control equipment, and costs associated with new or additions to existing foundations, ducting systems, control systems and/or control panels, utility connections, buildings or yard space. For purposes of the model, engineering costs include not only the planning of the control system, but also the cost of any "engineering economy" studies performed to determine which type of system will be chosen from the available alternatives. It will be assumed that the decision to install a control system has zero costs, i.e., is determined by some outside authority.

(d) Start-Up Costs include the full cost of any testing and trial runs of the installed system, including any associated production-line losses.

(e) Non-Recurring Taxes on the installed system, consisting primarily of sales tax, import tax or excise tax on system components are included in installed cost.

(f) Initial Cost of a Spare Parts Inventory is included as a component of installed cost, whereas the replacement of those inventory items actually used is included as an Operation and Maintenance Cost.

Operation and Maintenance Costs

(a) Labor Costs are the total man-hours by type of labor required (unskilled, skilled, managerial) for both routine operation and maintenance and periodic maintenance of each equipment type times the appropriate labor rate per hour summed over all labor types used.

(b) Utility Costs of the equipment (electricity, water, etc.), by type, times the cost per unit of the utility to the source are the chief components of operation costs.

(c) Spare Parts actually replaced are included in O&M costs (see (f) above), based either on operating experience or MTBF for the specific part. This item is included under working capital in Table 5-4.

(d) Production Line Losses due to downtime of the control equipment for maintenance or repair are an O&M expense. If this item is zero due to redundant control systems, the installed cost includes the full cost of redundancy.

(e) Disposal Costs of the collected pollutant--the total amount of pollutant collected, by type, times the cost per unit of its disposal to the source--is an O&M expense or credit. The cost of disposal may be a negative number from the O&M standpoint if the pollutant collected is recycled through the production line or sold as a byproduct.

Annual Capital Charge Percent

(a) Return on Investment in control equipment is included as part of the total annual cost of pollution control. For non-utility firms this cost is the opportunity cost of capital; for utilities, the allowed return on average net investment.* The inclusion of a return allowance presupposes that the individual firms will finance the purchase of all control equipment. If the equipment is provided by public funds, this is not an includable cost item.

(b) Annual Taxes (real estate, property, etc.) or Insurance levied on the control equipment itself, or on other property as a result of the addition of control equipment, are charged against capital.

(c) Depreciation Percent is determined primarily by the design-life of the type of equipment. The estimate used does not include weighting for equipment parts which are replaced on a regular basis and charged to O&M expense.

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*If the investment is funded by borrowing, this cost is the interest rate.

When it is possible to estimate the time to technological obsolescence for specific equipment designs, modifications in the depreciation estimate are made.

5.3.4 COST FUNCTIONS

In order to fit the available data into the Control Cost-Effectiveness Model, TRW derived equations expressing the purchase price of all control devices as a function of their efficiency level and size (gas volume). Using the least-squares method, a best-fit straight line was developed using five points from each curve of manufacturer's price in the Control Techniques documents. This was not necessary for oil desulfurization, whose price curves are linear. An advantage to linear equations is ease of computation. It must be noted that use of linear equations does introduce some error in the price estimates for certain devices, especially for large gas volumes. Therefore, the user should bear in mind the fact that cost estimates made for very large devices of certain types are likely to be understated.

(a) Manufacturer's Price - The first- and second-degree manufacturer's price equations obtained for all devices, together with their coefficient of correlation, are listed in Table 5-6. By comparing the R^2 values for the linear and quadratic forms, it can be seen that very little additional degree of fit is obtained by using the quadratic form of the equations.

The R^2 values associated with these equations cannot be interpreted in the usual sense as an indication of the amount of variation in the data points "explained" by the variables included in the equation. The R^2 values are only an indication of how close the equation comes to duplicating exactly the lines in the graphs contained in the Control Techniques documents. This interpretation of the R^2 values is necessary because no data points were published, and as previously mentioned, the equations were generated by reading off five points from each curve.

An additional reason for using the linear equations instead of the more precise quadratic forms is the failure of the coefficients of the x^2 term in the quadratic equations to pass the t-test for significance, and failure of the quadratic equation to pass the F-test for significance.

TABLE 5-6 MANUFACTURER'S PRICE
(COST FUNCTIONS Y = DOLLARS X 10^3, X = ACFM X 10^3)

CONTROL MEASURE	LINEAR FUNCTION	R^2 (LINEAR)	QUADRATIC FUNCTION	R^2 (QUADRATIC)
Wet Collector				
High Efficiency Medium Efficiency	$y = 2.886 + .228x$	.988	$y = 1.677 + .324x - .0009x^2$	.997
Low Efficiency	$y = 1.257 + .145x$	.997	$y = 1.621 + .116x + .0003x^2$	.999
Mechanical Collectors				
Gravity Collectors				
High Efficiency	$y = -.445 + .326x$	.999	$y = 2.088 + .203x - .00001x^2$	.999
Medium Efficiency	$y = -.042 + .155x$	.999	$y = 1.191 + .163x - .00001x^2$	.999
Low Efficiency	$y = .003 + .056x$	.999	$y = .397 + .097x + .00001x^2$	.999
Centrifugal Collectors				
High Efficiency	$y = 2.413 + .197x$	.999	$y = .074 + .257x + .001x^2$	.999
Medium Efficiency	$y = 1.507 + .157x$	.999	$y = -.019 + .152x + .00005x^2$	.999
Low Efficiency	$y = .244 + .099x$	.999	$y = .078 + .067x - .0002x^2$	.999
Electrostatic Precipitators				
High Voltage				
High Efficiency	$y = 42.413 + .623x$	.996	$y = .34.501 + .752x - .0002x^2$	.998
Medium Efficiency	$y = 31.243 + .441x$	.998	$y = 27.431 + .503x - .0001x^2$	.999
Low Efficiency	$y = 19.695 + 318x$	.999	$y = 22.908 + .265x + .0001x^2$	.999
Low Voltage				
High Efficiency	$y = 4.030 + 1.312x$	.998	$y = 2.236 + 1.485x - .002x^2$	.999
Medium Efficiency	$y = 3.599 + 1.140x$	.998	$y = 1.781 + 1.316x - .002x^2$	.999
Low Efficiency	$y = 3.219 + .968x$	.998	$y = 1.408 + 1.142x - .002x^2$	.999
Fabric Filters				
Type "A"	$y = 1.448 + .838x$	.999	$y = 1.077 + .719x + .0001x^2$	.999
Type "B"	$y = 3.478 + .448x$	.999	$y = 2.573 + .459x - .00001x^2$	.999
Type "C"	$y = 2.658 + .325x$	.999	$y = 2.157 + .353x - .0003x^2$	.999

TABLE 5-6 MANUFACTURER'S PRICE (CONTINUED)

CONTROL MEASURE	LINEAR FUNCTION	R^2 (LINEAR)	QUADRATIC FUNCTION	R^2 (QUADRATIC)
Increased Combustion Efficiency				
Catalytic Combustion	$y = 7.550 + 1.515x$	.995	$y = 7.640 + 1.478x + .002x^2$	.995
Catalytic With Heat Exchange**	$y = 7.550 + 1.515x$	.995	$y = 7.640 + 1.478x \ .002x^2$	.995
Direct Flame Combustion	$y = 5.713 + 1.174x$	.998	$y = 5.459 + 1.277x - .005x^2$	.999
Direct Flame With Heat Exchange**	$y = 5.713 + 1.174x$	.998	$y = 5.459 + 1.277x - .005x^2$	.999
1-Step Pressurized Combustion	$y = 8.00x$	No Estimate	Not Enough Data	
2-Step Pressurized Combustion	$y = 23.00x$	No Estimate	Not Enough Data	
MHD	$y = 18.00x$	No Estimate	Not Enough Data	
EGD	$y = 21.00x$	No Estimate	Not Enough Data	
Fuel Substitution*				
Fuel Desulfurization				
Coal Scrubber	$y = 2.340x$	No Estimate	Not Enough Data	
Oil Desulfurization	$y = .071 + 1.185x$	.862	$y = 0.38 + 694x + .465x^2$	.866
Flue Gas Desulfurization				
Alkalized Alumina	$y = 10.64x \ (600 \le x \le 1000)$	No Estimate	Not Enough Data	
Limestone Injection-Dry	$y = 3.750x$	No Estimate	Not Enough Data	
Limestone Injection-Wet	$y = 12.597 - .004x$	.999	$y = 12.703 - .005x - .000004x^2$	1.000
By-Product Manufacture***				
Sulfuric Acid Plant-Contact Process	$y = .445 + .322x$	.938	$y = .027 + .008x - .00001x^2$	.989
Sulfuric Acid Plant-Double Contact Process	$y = 1.03 + .002x$	.965	$y = .537 + .004x - .000002x^2$	.977
Sulfur Plant (2 Stage)	$y = .294 + .003x$	.971	$y = .213 + .004x - .000001x^2$	.999
Other Measures				
Auto Engine Modification	$y = 10x$	No Estimate	Not Enough Data	
Auto Exhaust Control Device	$y = 130x$	No Estimate	Not Enough Data	
Tall Stacks				
15' Diameter	$y = .001 + 3.040x$	.984	$y = -.027 + .440x + .002x^2$	.989
20' Diameter	$y = .001 + 3.080x$	.979	$y = -.052 + 1.480x + .001x^2$	.981
25' Diameter	$y = .098 + 3.150x$	.989	$y = .001 + 4.650x - .001x^2$	.991
30' Diameter	$y = .001 + 3.370x$	.995	$y = .001 + 3.670x - .0002x^2$	.995
CO Boiler	$y = (10^6 \times /40000)^{.67}$	No Estimate	Not Enough Data	

*Fuel substitution cannot be represented by a simple formula. A complete explanation of the procedure used to compute the cost of fuel substitution is found in Section 5.3.

**Heat exchangers are considered accessory equipment and their costs are included under installation costs.

***By-product manufacture involves the construction of a separate facility at the pollution source site. Manufacturer's price cannot be stated for such a facility. These equations therefore represent the installed cost of these control measures.

To simplify writing of the equations, the standard $y = a+bx$ and $y = a+bx+cx^2$ forms were used. y is the manufacturer's price of the device or measure, except for the group, "By-Product Manufacture," where y is the installed cost. The term x is the ACFM capacity of the device for all except the following: sulfur plant where x is tons of sulfur produced per day; tall stacks where x is the stack height in feet; alkalized alumina, limestone injection, pressurized combustion, MHD and EGD where x is kilowatts of power generated; oil desulfurization where the cost equation expresses total incremental cost per barrel as a function of percent reduction in sulfur content; and CO boilers where x is barrels of oil refined per day.

The dependent variable in these equations is a measure of the size of the device being considered. This size is assumed to match the size of the source to which it is being applied, since it is usually less expensive to use a large device rather than several smaller ones. When x is stack height, tons of sulfur produced, or kilowatts of power generated, the data on any source in the region are readily available. (For tall stacks, it will be assumed that no zoning regulations prohibit stacks above a certain height; therefore, any height may be chosen.) However, when x is the ACFM capacity of the device, some assumptions must be made since the emission inventory data (McGraw, 1968) currently available do not include this information on sources. The following example shows how these data are being generated for the RAPA demonstration.

Example: The Asphaltic batching plant in the St. Louis inventory.

1. Source data emissions are reported in the inventory:

   Controls: cyclone, scrubber
   Particulate emissions: 1.95 T/day
   SO_x emissions: zero
   Process rate: 40,000 T/yr.

2. Calculate daily process rate to determine size of plant, assuming operation is 6 days per week, 7 hours per day for 6 summer months

   Annual operating hours = (6) (7) (26) = 1,092 hr/yr

   Process rate = 40,000/1,092 = 36.6 T/hr. when operating.

3. Determine gas volume. Source, "Air Pollution Engineering Manual," NAPCA

On. p. 331, Table 95, Test C-234: A 42.0 T/hr plant had a measured stack gas volume of 17,000 scfm. This was a gas-fired drier.

NOTE: The St. Louis drier is assumed to be gas-fired since the SO_x emission is zero.

Calculate stack gas volume, assuming stack moisture content 20%, stack gas temperature 250°F

$$\text{Volume} = \frac{(17,200)(710)(1.20)}{(530)} = 27,600 \text{ ACFM}$$

(b) Corrosive Factor - The corrosive factor was developed to overcome the restriction of assuming that standard construction materials are used in all control devices, as was done in the Control Techniques documents. Points on the Control Techniques curves for some devices showed a variation several orders of magnitude greater than the indicated ± 20% when compared to known purchase costs for such devices. An examination of these high-variance cases indicated that the cost of a device would always be underestimated when applied to a highly corrosive emission source. The manufacturer's price, as obtained from the above equation, is multiplied by the following factors, if the source is a sulfur plant, sulfuric acid plant, or nitric acid plant.

Gas Temperature (°F)	Corrosive Factor
Less than 275°	1.7
Greater than 275°	5.0

The gas temperature referred to here is the temperature of the effluent gas stream before it enters the control device. This temperature is found in Table 5-4, Item E, and is not necessarily the same as the exit gas temperature contained in Table 5-3, Item L.

(c) Installed Cost - The installed cost of a device for a particular source is found by computing the installed cost factor (R') and multiplying this by the adjusted manufacturer's price, including corrosive factor where necessary. The installed cost-factor is the composite percent-increase in control device cost resulting from cost components in Items H-Q (Table 5-4).

$$R' = \sum_{i=H}^{i=Q} r,$$

where r is the percent increase due to the i^{th} installation cost factor.

Total installed cost, Column R of Table 5-4, is therefore

$$R = G\,(0.01\,R' + 1)$$

(d) Annual Capital Cost - The annual capital cost (Item W, Table 5-4) of a device to a source is given by the sum of all charges against capital [Item V] times the total installed cost of the device

$$W = R\,(0.01\,V)$$

(e) Operation and Maintenance Costs - The operations and maintenance cost equations for the various device types are listed below. All capital letters in these equations refer to Table 5-4.

Device Type	O&M Equation
Wet Collectors	$NN = BB[HH\cdot CC + DD\cdot EE + \frac{FF\cdot GG}{24}] + KK\cdot LL$
Mechanical Collectors	$NN = BB[Z\cdot E\cdot AA.CC + \frac{FF\cdot GG}{24}] + KK\cdot LL$
Electrostatic Precipitators	$NN = BB[HH\cdot CC + \frac{FF\cdot GG}{24}] + KK\cdot LL$
Fabric Filters	$NN = BB[HH\cdot CC + \frac{FF\cdot GG}{24}] + KK\cdot LL$
Afterburners	$NN = BB[HH\cdot CC] + II.JJ + KK\cdot LL$
Alkalized Alumina	$NN = 1.06\,[\frac{\text{Process rate}}{24}\cdot BB]$
Limestone Injection Dry Process	$NN = \frac{\text{Process rate}\cdot BB}{24}[0.17 + 0.07(\%\text{ sulfur content})EE] + 25{,}000$
Limestone Injection Wet Process	$NN = \frac{\text{Process rate}\cdot BB}{24}[0.196 + 0.0382(\%\text{ sulfur content})EE] + 130{,}000$
Pressurized Combustion	
1-Step	$NN = -.02(II\cdot JJ) + 1.5\times 10^{-6}\,(RR)$
2-Step	NN = (Same as 1-Step)

Device Type (Cont'd)	O&M Equation
MHD	$NN = -.539(II \cdot JJ) + 1.5 \times 10^{-6}(RR)$
EHD	$NN = -.282(II \cdot JJ) + 1.2 \times 10^{-6}(RR)$
Coal Cleaning	$NN = .065 + 0.00037$ (sulfur content of original fuel)
Oil Desulfurization	Not possible to identify O&M costs
Sulfuric Acid Plant	Not possible to identify O&M costs
Sulfur Plant	$NN = 3.685 -.0.0365 (FF) + 0.00025 (FF)^2$
Tall Stacks	
400 ft.-700 ft.	$NN = .04T$
700 ft.-1000 ft.	$NN = .03T$
Engine Modifications	$NN = 0$
Exhaust Control	$NN = (70/yr) \times$ No. of Autos.
CO Boiler	$NN = BB[HH \cdot CC] + II \cdot JJ + KK \cdot LL$

(f) Total Annual Cost - The total annual cost is the sum of the annual capital cost and the annual operation and maintenance cost.

$$XX = W + NN$$

(g) Fuel Substitution Costs - Fuel Switching (changing the type of fuel used, as switching from coal to gas) and Fuel Substitution (changing to a lower sulfur content variety of the same fuel) are among the most important means of reducing both sulfur oxide and particulate emissions. These methods, considered under the general title "fuel substitution" in this model, cannot be treated in quite the same way as other control devices, even though the same cost items (Installed Cost, Annual Capital Cost, O&M Cost) are required.

The primary cost involved in fuel substitution is the change in annual operating expense resulting from purchase of a more expensive fuel. This component of the total cost of fuel substitution is computed in the following way:

(1) Determine the fuel type being burned, its sulfur content, for each combustion source under consideration. If a source is burning more than one fuel type or significantly different varieties of the same type, locate the above data for each type. If the source is burning only one fuel initially and the fuel is gas, no substitution is allowed in the model. If the source is burning more than one fuel and gas is among them, then a substitution can be made subject to further assumptions specified below.

(2) Compute the annual Potential Heat Energy Output of each fuel burned by the source.

$$P{\cdot}H{\cdot}E{\cdot}O_{(M)} = \text{Heat Content}_{(M)} \times \text{Process Rate}_{(M)} \times \frac{\text{Annual Operating Hours}}{24},$$

where M is an identifier for fuel type. All variables in this equation are contained in the data file.

(3) Compute the actual heat energy output of each fuel burned by the source. This is given as the product of the boiler efficiency and the potential heat energy output. Boiler efficiencies vary with type of fuel burned and the level of BTU output of the boiler. The following table of efficiencies is contained in the data system:

	Coal	Oil	Gas
BTU Output Greater Than $.1 \times 10^9$	.87	.86	.82
BTU Output Less Than $.1 \times 10^9$	.75	.77	.80

Since the total BTU output of the source is not known a priori, the program initially assumes it to be greater than $.1 \times 10^9$, calls the appropriate efficiency from the data system, and multiplies it by the result of (2) above. A test is then performed to see if, in fact, the output is greater than $.1 \times 10^9$. If it is not, the second efficiency is called from the data system and used in the multiplication. If it is known that a particular emission source burns more than one type of fuel in the same boiler, the above efficiencies do not apply. In this case, a weighted efficiency is computed, based on the proportions of each fuel input to the process. After multiplication by the weighted efficiency, the BTU output check also is performed as detailed above.

(4) Sum the actual BTU output from each of the M fuel types burned by the source. This BTU output must be maintained after the fuel substitution has been made.

(5) If more than one fuel was burned originally, examine the sum computed in (4) above to see which fuel type contributed the largest percent to the total BTU output. This fuel then is identified by the program as the only original fuel in order to select the possible substitutions to be made. If this fuel is gas, then the only substitution allowed in the program is a substitution of gas for the other fuels being burned.

(6) The program next queries the data system to determine what kinds of fuel substitutions are allowed from this original fuel position. It then selects all alternatives with sulfur content less than the sulfur content of the original fuel.

(7) The old sulfur oxide emission rate is computed as a check on the validity of the assumptions made in steps (1) through (6) above. This is calculated from sulfur content and process rate. The calculated SO_x emission and the observed emission from the data system are printed for the user's information.

(8) The total annual cost of operating with the selected alternate fuel is computed by first determining the quantity of alternate fuel required to maintain the total BTU output and multiplying this by the cost per unit. The quantity of alternate fuel is found by substituting the new heat content and efficiency (if applicable) in the equation for actual heat energy output and solving for quantity of fuel. The total cost of operating with the original fuel is computed as the product of quantity and cost. The two fuel cost figures are subtracted to arrive at the incremental fuel cost.

(9) The new sulfur oxide emission rate is computed using the same equation as in step (7) above.

(10) A separate calculation of the annualized capital cost and any other incremental operation and maintenance costs associated with the fuel substitution must be made by the user and supplied as input to to the program. These costs, if any, are computed using the methodology set forth in Sections 4.4 (a) through (f).

(11) The program adds the "other charges" from (10) above to the increased fuel cost and arrives at the total annual cost of fuel substitution.

(12) The effectiveness of the fuel substitution in reducing sulfur oxide and other pollutant emissions is computed as the change in emissions divided by the old emission rate.

(13) The results of all applicable fuel substitutions are entered in the cost-effectiveness data file and are printed for the user's information. These results are available as inputs to the Abatement Strategy and Regional Econometric Models.

5.4 REFERENCES

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6. ABATEMENT STRATEGY MODEL

6.1 PURPOSE

Air quality regions are expected to develop implementation plans designed to achieve and maintain air quality standards. The foundation of these implementation plans is the abatement strategy, which prevents or controls air pollution source emissions within a specified timetable. The emission limitations of an abatement strategy generally include items such as source emission standards applicable to processes or combustion limitations, regulations pertaining to the sulfur content of fuel, rules for the location of new industrial plants and other sources of air pollution, restrictions on open burning, plans for disposal of solid wastes, and so on.

The purpose of the Abatement Strategy Model is to provide a reasonably accurate and quantitative procedure for testing the impact of alternative abatement strategies in a computer-processed mathematical model. The Abatement Strategy Model provides a means for simulating and optimizing the control of regional air pollution source emissions, according to a variety of strategies aimed at achieving regional air quality goals, and for assessing the degree to which these goals are met. Thus, the model allows the RAPA program to be used as a "gaming" tool, with the user specifying an abatement strategy, observing the resulting change in regional air quality, and, on the basis of the results, modifying his specifications for another "run."

6.2 DESIGN SUMMARY

The Abatement Strategy Model has the capability of applying equiproportional and differential strategies via an optimization mode which estimates source controls with a standard linear programming technique. In addition, the model applies source emission standards, fuel substitution, and maximum control strategies in a mathematical simulation mode. Each of these strategies and operating modes is described briefly in the following paragraphs, and in detail in Section 6.4. Due to computer limitations, the two operating modes are handled as separate entities in the current RAPA program.

In the context of the RAPA program, abatement strategies are defined as preventive or controlling schemes directed at segments of the pollution sources (e.g., combustion sources, industrial sources, federal facilities) with selected types of regulations (e.g., process weight restrictions, zoning). Specifically, the present RAPA program design includes: 1) a strategy whereby every air pollution source adopts maximum control technology; 2) a strategy of differential emission standards, whereby each air pollution source is required to reduce pollutant emission on the basis of its pollutant contribution and its physical location in the pollution environment; 3) a strategy to limit the use of certain fuel types; and 4) source emission standard strategies whereby all air pollution sources are asked to adhere to a set of specific regulations, designed to limit pollutant emissions as a function of industrial or combustion processes.

An abatement strategy is considered to be an overall plan which specifies the types of air pollution sources to be controlled and how they are to be controlled, in order to reduce the chronic, or long-term air pollution problem. For example, a strategy for achieving a given SO_x air quality goal might be to legislate source emission standards, which are to be in effect over a long period of time, for certain types of combustion sources. In contrast with strategies are tactics, which are those control actions taken to alleviate the acute or short-term pollution problems. Fuel substitution is an example of a control technique which may be used either to achieve long-term reduction or as a short-term tactic in episode situations.

There is a significant interaction between control of long-term and short-term air pollution problems. Reduction in average long-term ground-level concentrations results in a correspondingly reduced frequency of episode conditions. The Abatement Strategy Model, in conjunction with the statistical segment of the Atmospheric Diffusion Model, allows the user to observe estimates of the interaction between chronic and acute regional air pollution problems.

The model, in connection with the Control Cost-Effectiveness Model, defines the type of control techniques which would be used by each air pollution source facility to meet the proposed source emission requirements. Inherent in the model is the assumption that individuals or corporations will use the control techniques resulting in the least cost to the source facility. Therefore, a simulation of a strategy with assumed least-cost control measures applied to the source of pollution assists the user in the evaluation of implementation plans with reasonable ground-level pollutant concentrations and direct control costs.

The Abatement Strategy Model exercises the models in the RAPA program to evaluate the regional impact of selected strategies in terms of: 1) the types of sources affected by the strategy; 2) the degree to which these sources are affected in terms of control costs; 3) the resulting change in pollutant emissions; and 4) regionally aggregated values of control costs by source category, total reduction in pollution emissions, changes to regional fuel-use patterns, resulting air quality levels, and indirect economic effects.

6.3 ABATEMENT STRATEGIES

Development of an implementation plan requires answers to two basic questions:

(a) Which types of sources must be controlled?

(b) What degree of control must be applied?

The strategies that form the implementation plan should be the product of a comprehensive assessment of the nature and extent of the air pollution problem, including a review of the existing air quality conditions as portrayed by the Atmospheric Diffusion Model, types of sources and their emissions cataloged by the Data File, and available control techniques defined by the Control Cost-Effectiveness Model. Based on this assessment, various emission-control strategies can be formulated which then must be tested in a systematic, quantitative procedure to see if they bring about regional goals specified by air quality standards.

Several abatement strategy types are currently implemented in the RAPA program. More details on their implementation are provided in later sections of this chapter.

6.3.1 Differential Control Strategy

Application of a differential control strategy requires that reductions in source emissions to meet the air quality goal will result in the lowest possible total cost to the region. This strategy also is referred to as a "least-cost" or optimal control strategy. By assuring that each dollar allocated for regional emission control produces the maximum possible increase in the air quality level, several applications of this "least-cost" principle will produce an aggregate minimum control cost when summed over all regional sources.

Specific reduction requirements for each source can be achieved through the method of differential controls, associating a cost of incremental reduction of emission with each source. Although this strategy results in the least total direct cost to pollution sources within a region, it is extremely difficult to impose. Because of differences in location within the region, sources of one type may have emission reduction requirements significantly different from those applied to the same source-type located elsewhere. Therefore, the differential control strategy would be very difficult to legislate.

6.3.2 Maximum Control Strategy

The maximum control strategy forces source emission reductions in accordance with the maximum that is technically possible with available control technology, regardless of economic and institutional impacts to the region. Use of this strategy in the Abatement Strategy Model provides data on the best air quality that the region could achieve using available control technology. Results of this strategy provide preliminary guidance for future research and development in the area of control technology.

6.3.3 Fuel Substitution Control Strategy

The fuel substitution strategy includes switching from one type of fuel to another (e.g., coal to gas), and substitution of one class of fuel for another class within the same fuel type (e.g., high-sulfur coal for low-sulfur coal). In addition, this strategy considers equivalent fuel substitution, where any type of control measure or control device may be adopted as long as the pollution emission results are less than or equal to the equivalent fuel substitution control measure.

6.3.4 Source Emission Regulation Control Strategy

The source emission standard strategy offers a practical and expedient approach to meeting air quality standards. Included in this strategy could be such regulations as source emission standards calling for manufacturing process weight regulations, restrictions on flue gas concentrations, limitations on a source's contribution to ground-level concentrations, combustion efficiency regulations, and so on. Both the process weight and combustion-efficiency source emission standards are implemented in the Abatement Strategy Model. The resulting air quality levels and control costs are observed in order to determine whether or not the regional air quality goals have been met. Although these strategies are not necessarily the most cost-effective, they can be implemented with effective legislative practices.

6.4 OPERATING MODES

The Abatement Strategy Model considers two types of operating modes, the optimization mode and simulation mode.

6.4.1 Optimization Mode

The optimization mode of the Abatement Strategy Model provides a means of determining the least-cost method of meeting regional air quality standards with a differential control strategy. A linear program is used in the optimization mode with the restraints that the receptor ground-level concentrations must meet the regional air quality standards and that the cost function must be at a minimum. A standard, commercially available, linear programming package is used in deriving this least-cost solution.

Short-term, tactical control measures, as well as strategic, long-term control can be analyzed in the optimization mode by replacing long-term functions with short-term functions and incremental costs of short-term control measures. The long-term air quality standards are replaced by an upper tolerance limit, reflecting acute short-term air quality standards.

6.4.2 Simulation Mode

In order to determine the resulting regional impact of various emission control regulations, the Abatement Strategy Model allows the user to simulate the application of several types of uniform source emission control regulations. The model provides resulting emission reductions, air quality levels, and control costs for these alternative regulations.

There are four general types of source emission regulations which may be simulated in the Abatement Strategy Model:

(a) Fuel sulfur content limitation

(b) Equivalent fuel sulfur content limitations

(c) Pollutant emission as a function of combustion heat input

(d) Pollutant emission as a function of input process weight.

In addition, the maximum control technology strategy may also be applied in this mode. The user selects the regulations to be simulated, and specifies the source types to be controlled.

The application of the emission standard to the selected source types results in new emission values, control costs, and a change in the region's ground-level pollutant concentrations. A comparison of the new ground-level concentrations with the desired air quality standard may require the application of stricter values to the selected source emission regulation, or the selection of a new type of regulation with different emission reduction potentials.

6.5 OPTIMIZATION MODE MODEL STRUCTURE

The optimization segment of the Abatement Strategy Model has been formulated to provide guidelines for the least-total-cost method of controlling regional air quality. The optimization segment is primarily a resource allocation model, i.e., given a regional air quality goal, it will determine the least-total-cost set of source emission reductions to achieve this goal. Direct control cost, without consideration of the "who-pays" question, has been selected as the measure of efficiency to be minimized. In a strict economic sense, it is desirable to select the control set at which marginal control cost is equal to the marginal benefit. However, a lack of comprehensive damage functions has precluded this approach and, thus, least-total-cost has been selected as the economic criteria.

The optimization mode has been formulated in a manner which is compatible with linear programming solution techniques for a variety of reasons. First of all, a preliminary analysis of RAPA cost functions showed reasonably high correlation coefficients for linear approximations of control cost as a function of efficiency. Secondly, in order to incorporate the influence of regional meteorology in terms of atmospheric diffusion and diminution of pollutants, the size of the model increases so greatly that it is not compatible with any other available mathematical optimization techniques. Thirdly, this approach does not require the formulation of new mathematical solution techniques. There are several available linear-programming algorithms which have been programmed and checked for various computers, and are relatively straightforward for use in terms of problem format and input data. These algorithms tend to be very efficient computationally for problems such as the Abatement Strategy Model formulation and, thus, do not result in excessive computer requirements.

The purpose of the optimization segment is to provide a model which determines least-cost combinations of source emissions to achieve stated air quality objectives. For the optimal solution, each source will be assigned a level of emission reduction which results in least total control cost, and meets ground-level concentration constraints.

Basically, the model relates the emissions at each source in the region to the air quality, or ground-level concentration, at a set of receptor points, dispersed throughout the region via a set of transfer coefficients obtained as an output of the Atmospheric Diffusion Model. With this approach, the control of localized pollutant "hot-spots" is achieved, as well as control of the central area of the region. This is particularly important for air quality control regions which include a number of geographically separated centers and industrial areas.

Since source emissions coupled with source-receptor transfer coefficients determine resulting ground-level concentration, the model contains a set of inequality constraints, which restrain the ground-level concentration at each receptor location to a point less than the value selected as an air quality goal for the region. With the model, it is possible to have different goals, or standards, for geographic subdivisions of the region. Long-term (annual or seasonal) average pollutant ground-level concentrations are used, although shorter term averages could be used with the model as formulated, if the appropriate set of transfer coefficients were available.

Another consideration in the model is the relationship between source control technology, control costs, and control effectiveness at each pollutant source in the region. The Control Cost-Effectiveness Model is used to determine the least-cost source control equipment mix required to obtain given levels of reduction of pollutant emissions. Here, a key assumption is that control costs are approximately linear and proportional to the level of reduction in emission at each pollutant source. The amount of control to be applied to each source is constrained to a point less than or equal to that which is technologically possible at this time. Additional constraints on the sources may be imposed to insure that a given source achieves a minimum level of emission reduction.

Thus, with the previously mentioned constraints, the model minimizes total direct control costs for the region in the following manner:

Let $f_{ijk}(E_{ij})$ be the transfer function between the average ground-level concentration (g.l.c.) of the jth pollutant at the kth receptor from the ith source, and let n_i, n_j, n_k be the total number of sources, pollutants and receptors to be considered, respectively. Values of this transfer function are are currently computed by the Atmospheric Diffusion Model for seasonal and annual averages. The ground-level concentration observed at the kth receptor of the jth pollutant is then

$$\chi_{jk} = \sum_{i=1}^{n_i} f_{ijk}(E_{ij}). \tag{1}$$

If χ°_{jk} and χ_{jk} are the g.l.c. of the jth pollutant at the kth receptor before and after control of this source, and E°_{jk} and E_{jk} are the source emission levels of the jth pollutant at the ith source before and after control, then

$$\chi^{o}_{jk} - \chi_{jk} = \sum_{i=1}^{n_i} \left[f_{ijk}(E^{o}_{ij}) - f_{ijk}(E_{ij}) \right]. \tag{2}$$

If the required reduction is defined as

$$X_{ij} = E^{o}_{ij} - E_{ij} \tag{3}$$

and the usual linearity assumption is applied, i.e.,

$$f_{ijk}(A+B) = f_{ijk}(A) + f_{ijk}(B), \tag{4}$$

then

$$X^{o}_{jk} - X_{jk} = \sum_{i=1}^{n_i} f_{ijk}(X_{ij}). \tag{5}$$

The function of the Control Cost-Effectiveness Model is to make available for each source, i, a unique cost function, $C_{ij}\ (X_{ij})$, in the form

$$C_{ij}\ (X_{ij}) = C_1 + C_2\, X_{ij} + C_3\, X_{ij}^{\ 2} + \ldots\ldots.\ C_n\, X_{ij}^{n-1}. \tag{6}$$

This cost function represents the minimum total cost of achieving a reduction of an amount X_{ij} in the emissions of the jth pollutant from the ith source. Thus, for a given set of source control measures, $[X_{ij}]$, the total direct cost to the region will be given by

$$C_T = \sum_{i=1}^{n_i} \sum_{i=1}^{n_i} C_{ij}\ (X_{ij}), \tag{7}$$

and the corresponding set of ground-level concentration reductions, $[X^{o}_{jk} - X_{jk}]$, will be given by equation (5).

At this point, the control strategy, or means of selecting the preferred set of control measures $[X_{ij}]$, is introduced. In general, there are two basic approaches. The required set of control measures may be computed by an input scheme, such as applying an equiproportional emission standard to the relevant sources. For each source requiring a maximum allowable emission level of E_{ij}^{max}, the reduction is expressed by

$$X_{ij} = E_{ij}^{o} - E_{ij}^{max} . \tag{8}$$

Alternatively, an optimum set $[X_{ij}]$ could be computed by some preference criteria. The most widely utilized preference criterion is an econonic one, the so-called least total cost to achieve a given g.l.c. standard.

Although these standards are generally stated in terms of concentration and relative frequency of occurrence, an arithmetic average g.l.c. requirement is always implicit in these statements.

Denoting the average g.l.c. required by the standard for the jth pollutant as S_j, and requiring that no receptor within the region have a g.l.c. greater than the given standard, there are constraints on both the least-cost and equiproportional strategy so that

$$X_{jk} < S_j \tag{9}$$

for

$$j = 1,2,.....n_j \tag{10}$$

$$k = 1,2,.....n_k \tag{11}$$

or, substituting in equation (1),

$$X^{o}_{jk} - f_{ijk}(X_{ij}) < S_j \quad . \tag{12}$$

Under the assumption that

$$f_{ijk}(X_{ij}) = A_{ijk} X_{ij}, \tag{13}$$

the expanded set of constraints is shown in Table 6-1.

The least-cost strategy requires that

$$C_T = \text{minimum}, \tag{14}$$

subject to the constraints of Equation (12). If the cost functions (which must be minimum cost functions in the sense that they represent a selection from all available source control techniques for achieving a specified reduction) are approximated by linear functions,

$$C_{ij}(X_{ij}) = C_1 + C_2 X_{ij}. \tag{15}$$

The problem formulated is amenable to solution by linear programming techniques. Specifically, two linear programming packages are available for performing the indicated optimization.

The PDQ/LP package, developed by Control Data Corporation, is being utilized for the initial RAPA demonstration program. This program is designed to provide extremely rapid solutions of small to medium-sized linear programming problems on the CDC 6600 computer. The program utilizes an upper-bounded standard simplex solution algorithm. The program will handle problems of up to 250 rows (including two objective rows) and up to 300 columns, including the right-hand side of the inequality constraints. Thus, a maximum of 248 receptor points and 299 sources within a region would be considered.

TABLE 6-1. CONSTRAINTS ON SOURCE EMISSION CONTROL LEVELS

G.L.C. Before Control		Source 1		Source 2				Source N		G.L.C. After Control	
X°_{11}	-	$[a_{111}x_{11}$	+	$a_{211}x_{21}$	+	...	+	$a_{N11}x_{N1}]$	$\leq$	s_1	POLLUTANT 1, RECEPTOR 1
X°_{12}	-	$[a_{112}x_{11}$	+	$a_{212}x_{21}$	+	...	+	$a_{N12}x_{N1}]$	$\leq$	s_1	POLLUTANT 1, RECEPTOR 2
.		.		.				.		.	.
.		.		.				.		.	.
.		.		.				.		.	.
X°_{1M}	-	$[a_{11M}x_{11}$	+	$a_{21M}x_{21}$	+	...	+	$a_{N1M}x_{N1}]$	$\leq$	s_1	POLLUTANT 1, RECEPTOR M
X°_{21}	-	$[a_{121}x_{12}$	+	$a_{221}x_{22}$	+	...	+	$a_{N21}x_{N2}]$	$\leq$	s_2	POLLUTANT 2, RECEPTOR 1
.		.		.				.		.	.
.		.		.				.		.	.
.		.		.				.		.	.
X°_{2M}	-	$[a_{12M}x_{12}$	+	$a_{22M}x_{22}$	+	...	+	$a_{N2M}x_{N2}]$	$\leq$	s_2	POLLUTANT 2, RECEPTOR M
X°_{31}	-	$[a_{131}x_{13}$	+	$a_{23}x_{23}$	+	...	+	$a_{N31}x_{N3}]$	$\leq$	s_3	POLLUTANT 3, RECEPTOR 1
.		.		.				.		.	.
.		.		.				.		.	.
.		.		.				.		.	.
X°_{3M}	-	$[a_{13M}x_{13}$	+	$a_{23M}x_{23}$	+	...	+	$a_{N3M}x_{N3}]$	$\leq$	s_3	POLLUTANT 3, RECEPTOR M

As previously stated, the model formulation is compatible with analysis of tactical, short-term control measures, as well as strategic, long-term control. In this situation, the source-receptor transfer functions, $f_{ijk}(E_{ij})$, are replaced by the functions applicable in the short-term control measures being considered. The normal long-term cost functions are replaced with incremental costs of short-term control measures available for each source. The constraints, S_j, are replaced by a set of g.l.c.'s, which represent the upper limit tolerable in the acute situation. The model, as formulated, then computes a minimum-cost set of control measures for this situation.

6.5.1 Optimization Mode - Model Inputs

The input information required by the PDQ/LP linear programming package is shown in Table 6-2.

Input data, grouped under the heading MATRIX, consists of information extracted from the Control Cost-Effectiveness Model. A two-dimensional matrix is formed whose elements are of two types. The source cost elements (e.g., 500001 COST) represent the cost factor (i.e., C_i in Equation (1)) for each of the controllable sources. The source-receptor elements (e.g., 500001 R00001) are the a_{ij}'s of Equation (2). The MATRIX data are listed so that for each source all the matrix elements associated with that source are presented in sequence, with the source cost element being the first item in the group.

The next set of input data, headed RHSIDE, consists of the R_j's of Equation (2) for each receptor point. These values represent the minimum concentration-level reduction necessary to meet the standard. The negative values indicate the concentration is presently below the standard, implying no control is required, but, since zero (i.e., zero control) is greater

TABLE 6-2 ABATEMENT STRATEGY OPTIMIZATION MODE INPUTS

```
MATRIX                                      RHSIDE
      S00001   COST     157.20000                         R00001    -59.40000
      S00001R00001         .01532                         R00002    -55.80000
      S00001R00002         .02206                         R00003    -52.70000
      S00001R00003         .03158                         R00004    -51.30000
      S00001R00004         .04047                         R00005    -53.80000
      S00001R00005         .05374                         R00006    -37.80000
      S00001R00006         .01796                         R00007    -31.80000
      S00001R00007         .02489                         R00008    -28.20000
      S00001R00008         .04671                         R00009    -26.30000
      S00001R00009         .09420                         R00010    -39.50000
              010          .15923                         R00011    -43.40000
                1          .02623                         R00012    -15.00000
      S00022R              .03167                         R00013     37.60000
      S00022R00            .06145                         R00014     23.90000
      S00022R0002                                         R00015     21.50000
      S00022R00023                                        R00016    -49.70000
      S00022R00024                                        R00017    -27.00000
      S00022R00025         .01624                         R00018     27.50000
      S00023   COST     922.00000                         R00019      8.60000
      S00023R00001         .02620                         R00020     34.40000
      S00023R00002         .03156                         R00021    -54.00000
      S00023R00003         .03649                         R00022    -42.30000
      S00023R00004         .04814                         R00023    -36.30000
      S00023R00005         .03960                         R00024    -35.20000
      S00023R00006         .03811                         R00025    -43.10000
      S00023R00007         .06333

              BOUNDS
               UP              S00001             19.08000
               UP              S00002              8.18000
               UP              S00003              7.90000
               UP              S00004              2.97000
               UP              S00005              4.57000
               UP              S00006              2.27000
               UP              S00007             14.87000
               UP              S00008              2.03000
               UP              S00009              2.47000
               UP              S00010              2.47000
               UP              S00011              3.40000
               UP              S00012              4.94000
               UP              S00013              1.48000
               UP              S00014             21.50000
               UP              S00015              1.96000
               UP              S00016              3.46000
               UP              S00017              2.03000
               UP              S00018             95.00000
               UP              S00019              1.88000
               UP              S00020              4.01000
               UP              S00021             13.60000
               UP              S00022              5.95000
               UP              S00023             19.77000
```

than a negative number, the negative values can be used as a criterion in Equation (2).

The final set of input data is headed BOUNDS. Corresponding to the value X_i^{max} of Equation (3), each value denotes the maximum emission reduction possible for each of the 23 sources under examination.

6.5.2 Optimization Mode-Model Output

Table 6-3 illustrates the output format for the optimization mode. The first output is the total control cost to the region under a differential control strategy designed to minimize regional costs. The SLACK VARIABLES, under the column labelled VALUE, indicate the amount by which the concentration levels at each receptor differ from the air quality standard.

The STRUCTURAL VARIABLES output indicates:

(a) VALUE - the amount of pollutant emission reduction (tons/day) required at each source for the optimal solution.

(b) STATUS - the maximum (AT MAX), minimum (AT MIN), or in between (IN BOS) pollutant concentration reduction required at each source.

(c) MAX VALUE - the maximum pollutant emission reduction (tons/day) possible at each source.

(d) COST OF BND - an internal variable.

(e) INPUT COST - the cost of reducing emissions ($/ton) at each source.

6.6 SIMULATION MODE

The simulation mode of the Abatement Strategy Model allows the user to examine the direct costs and the average ground-level concentration of pollutants resulting from the application of three general strategy types--maximum control, fuel changes, and source emission regulations. If the user elects to look at maximum controls, in other words to examine the maximum possible change in emissions regardless of the regional costs

TABLE 6-3 ABATEMENT STRATEGY OPTIMIZATION MODE OUTPUTS

```
       PDQ/LP RESULTS
       NAME       VALUE           STATUS      MIN VALUE        MAX VALUE    COST OF HND(DJ)  INPUT COST(CJ)
       ----   --------------     --------   --------------   -------------- --------------   --------------
       COST   1127108.790893                                 * * * * * OBJECTIVE * * * * *

****  SLACK VARIABLES

    1  R00001        63.938310    -SLACK        0.000000          NONE            NONE             NONE
    2  R00002        61.062765    -SLACK        0.000000          NONE            NONE             NONE
    3  R00003        58.790546    -SLACK        0.000000          NONE            NONE             NONE
    4  R00004        57.901558    -SLACK        0.000000          NONE            NONE             NONE
    5  R00005        60.159166    -SLACK        0.000000          NONE            NONE             NONE
    6  R00006        50.663665    -SLACK        0.000000          NONE            NONE             NONE
    7  R00007        42.397576    -SLACK        0.000000          NONE            NONE             NONE
    8  R00008        41.037105    -SLACK        0.000000          NONE            NONE             NONE
    9  R00009        39.079861    -SLACK        0.000000          NONE            NONE             NONE
   10  R00010        51.712505    -SLACK        0.000000          NONE            NONE             NONE
   11  R00011        51.501843    -SLACK        0.000000          NONE            NONE             NONE
   12  R00012        33.104170    -SLACK        0.000000          NONE            NONE             NONE
   13  R00013    0.               -SLACK        0.000000          NONE      131333.282805          NONE
   14  R00014         4.681857    -SLACK        0.000000          NONE            NONE             NONE
   15  R00015        29.266531    -SLACK        0.000000          NONE            NONE             NONE
   16  R00016        56.699603    -SLACK        0.000000          NONE            NONE             NONE
   17  R00017        40.741865    -SLACK        0.000000          NONE            NONE             NONE
   18  R00018          .647942    -SLACK        0.000000          NONE            NONE             NONE
   19  R00019        20.626445    -SLACK        0.000000          NONE            NONE             NONE
   20  R00020    0.               -SLACK        0.000000          NONE        1024.358657          NONE
   21  R00021        59.931071    -SLACK        0.000000          NONE            NONE             NONE
   22  R00022        51.165702    -SLACK        0.000000          NONE            NONE             NONE
   23  R00023        47.411230    -SLACK        0.000000          NONE            NONE             NONE
   24  R00024        47.403487    -SLACK        0.000000          NONE            NONE             NONE
   25  R00025        52.921683    -SLACK        0.000000          NONE            NONE             NONE

****  STRUCTURAL VARIABLES
    1  S00001        19.080000    AT MAX        0.000000      19.080000     -8083.617033       157.200000
    2  S00002         8.180000    AT MAX        0.000000       8.180000     -8006.163223       333.000000
    3  S00003         7.900000    AT MAX        0.000000       7.900000    -11171.639575      9873.400000
    4  S00004         2.970000    AT MAX        0.000000       2.970000     -3082.634099      8686.800000
    5  S00005    0.               AT MIN        0.000000       4.570000     97178.776135    100656.000000
    6  S00006         2.270000    AT MAX        0.000000       2.270000    -25397.535451      9955.900000
    7  S00007        14.870000    AT MAX        0.000000      14.870000    -11489.470375     27168.700000
    8  S00008         2.030000    AT MAX        0.000000       2.030000    -41834.703628     10837.600000
    9  S00009         2.470000    AT MAX        0.000000       2.470000    -58046.952568      9757.000000
   10  S00010         2.470000    AT MAX        0.000000       2.470000    -38793.253422      9757.000000
   11  S00011         3.400000    AT MAX        0.000000       3.400000     -3572.864102     32647.000000
   12  S00012         4.940000    AT MAX        0.000000       4.940000    -97143.637784      8785.400000
   13  S00013         1.480000    AT MAX        0.000000       1.480000    -26907.535451      8445.900000
   14  S00014        10.923894    IN BDS        0.000000      21.500000         NONE          7441.800000
   15  S00015    0.               AT MIN        0.000000       1.960000    110006.820281    116326.000000
   16  S00016    0.               AT MIN        0.000000       3.460000      1460.836443      7803.400000
   17  S00017    0.               AT MIN        0.000000       2.030000     36476.555110     42857.100000
   18  S00018        36.915085    IN BDS        0.000000      95.000000         NONE          6505.300000
   19  S00019    0.               AT MIN        0.000000       1.880000     18902.265197     37234.000000
   20  S00020         4.010000    AT MAX        0.000000       4.010000    -57846.307914      2942.600000
   21  S00021        13.600000    AT MAX        0.000000      13.600000    -32332.593508       367.600000
```

involved, then by definition all sources within the region are affected. If the user elects to look at fuel changes or source emission regulations on the other hand, three essential questions must be answered before computations can proceed:

(a) Which sources within the region are to be controlled?

(b) What type of regulation is to be applied?

(c) What degree of control within the regulation type is to be considered?

Prior to an execution of the Abatement Strategy Model, the user will have no way of determining whether or not the strategy, degree of control, and source selections will result in the region meeting its air quality goals. The simulation mode is a "guessing" tool in this regard. The model performs a comparison of the new air quality ground-level concnetrations with the desired air quality goal at the end of each run, and prints this information along with the aggregate cost of achieving this pollutant concentration level. If all the selected strategy levels and source combinations fail to meet the air quality goal, the user can perform another run of the model with a new listing of strategies, based on the results of previous runs.

The various strategies which can be handled by the simulation segment of the model are as follows:

(a) Maximum Control Strategy - The maximum control strategy is evaluated for every source within a region. The strategy model selects a source, then searches the data available in the Control Cost-Effectiveness Model to determine which applicable control measure for that source is the most efficient. The cost and efficiency of this device is retained for further computation. After selection of a control device or measure for each source, the direct cost of control is summed for all sources and resulting pollutant emissions then are computed. The change in pollutant emissions for each source is computed. This information is available as direct output to the user, and is used to obtain new ground-level concentrations. The user, therfore, can compare the change in emissions, and the program compares the ground-level concentration to some air quality goal to determine whether or not the goal can be reached with existing technology. No decisions are made on the basis of cost in this case.

(b) Fuel Sulfur Content Limitation - Fuel sulfur content limitations apply only to combustion sources of pollutants within a region. This strategy directly controls only sulfur oxides, but use of lower sulfur content fuels also has a side impact on particulate emissions. Only three levels of sulfur content restrictions are considered in the model: 2% sulfur, 1% sulfur, and 1/2% sulfur. Application of this strategy forces all sources to burn fuel with a sulfur content no greater than the specified value. Each source is free, however, to burn the cheapest fuel available to it under this restriction. Therefore, some sources may, for cost reasons, burn a fuel with lower sulfur content than the specified value. The model assumes that all sources burning gas will continue to do so.

Under this strategy, the Control Cost-Effectiveness Model is run only for the combustion sources specified and with the fuel substitutes specified. The least-cost fuel substitution for each source is selected and the change in emissions computed. Then, costs and emissions are summed for all sources in the region, new ground-level concentrations are computed using the Atmospheric Diffusion Model, comparisons to the air quality goal are made, and the results are printed for the user.

(c) Equivalent Fuel Sulfur Content Limitation - This strategy, like fuel sulfur content limitations, applies only to combustion sources, and control of sulfur oxide emissions is the only goal. As before, three sulfur content levels can be specified: 2% sulfur, 1% sulfur, and 1/2% sulfur. Application of the strategy allows a source to either burn a fuel with sulfur content equal to or less than the specifield level, or to employ some other type of control device or control measure to achieve the same total emissions as would have resulted from fuel substituion.

In this case, the Abatement Strategy Model first performs a search through the results of the Control Cost-Effectiveness Model, but selects the least-efficient fuel substitution involving fuel with sulfur content less than or equal to the specified value instead of selecting the least-cost substitution. Then, a second search of the Control Cost-Effectiveness Model data results is made to determine which other possible devices or measures will control the source with the same or greater efficiency. From among this second set of devices, the least-cost device is selected, and its cost compared to that of the least-efficient fuel substitution. The cheaper of these two controls then is selected by the model, and summations, comparison, and output are performed as in paragraph b) above.

(d) Combustion Regulation - The control strategy applied to combustion equipment is based on heat input. This type of regulation is commonly applied to fuel-burning air pollution sources. The specific regulation currently utilized in this model is that adopted by the City of St. Louis, Missouri. The maximum emission allowed under this strategy is computed by the use of the following equation:

$$50 = \frac{2.22\ D\ Q_h^{\ 0.27} \times 10^{-3}}{A\ H_s}$$

H_s = stack height in feet; if H_s is less than 50 feet, 50 feet is used in the calculation.

Q_h = total heat input in BTU per hour.

A = coefficient with value of 1 when $Q_h \geq 4 \times 10^9$ BTU per hour.

If Q_n is less than this value, then:

A = 0.67 when $H_s \leq 150$ feet or

A = 0.80 when $H_s \geq 150$ feet.

With the information stored in the source data file, it is possible to determine the maximum allowable emission, D, in pounds of particulate matter per million BTU heat input. According to the regulation, if the value of D as obtained above exceeds 0.6, then D shall be set at 0.6.

After the permissible level of emissions for a source has has been determined, the lowest cost control device which allows the source to comply with the regulation is located in the cost-effectiveness data file.

(e) Process Weight Regulation - As representative of control regulations applying to manufacturing operations, a process weight regulation was selected. The particular restriction used in this demonstration is one which has been adopted by San Francisco Bay Area, St. Louis, Missouri, and several other control agencies. The maximum allowable emissions (E) in pounds of particulate matter per hour are given by two equations.

$$E = 4.10\ p^{\ 0.67},$$

when process weight (p) is less than 30 tons per hour, and

$$E = 55.0 \ p^{0.11} - 40,$$

when

$$p > 30 \text{ tons per hour.}$$

The maximum allowable emission from a manufacturing source may be determined from these equations by using the source's process rate as given in the source emission file.

6.6.1 Simulation Mode - Model Inputs

The outputs from the Atmospheric Diffusion Model and the Control Cost-Effectiveness Model are necessary for the Abatement Strategy Model. The Atmospheric Diffusion Model provides the source-receptor transfer function, which refers to all sources, receptors, seasons, and pollutants. In order to calculate the new gound-level concentrations, the Abatement Strategy Model multiplies the new source emission rate, resulting from the application of one of the strategies, by the transfer function. Several outputs from the Control Cost-Effectiveness Model are needed. To provide applicable controls for each device, the Control Cost-Effectiveness Model selects those controls which physically can be applied to the source. Then it reads the cost and efficiency of the control device as a ratio of new emissions to the old emission, forming a set of tables. In this manner, costs of all control equipment, including fuel-substitution schemes, are determined.

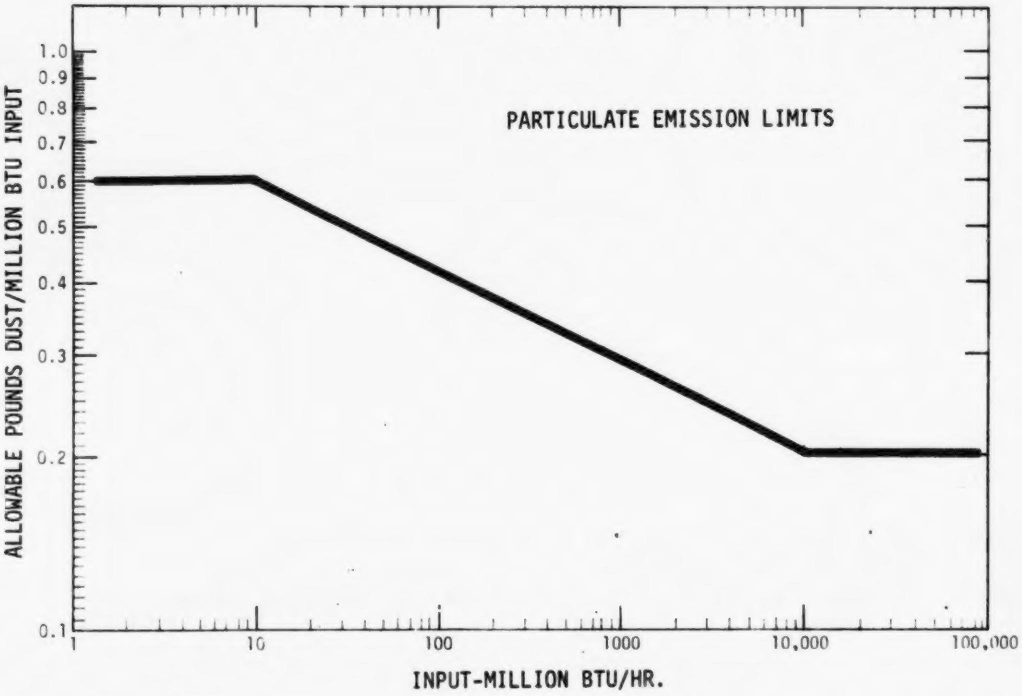
The RAPA program data files contain the emission inventory data necessary to run the Abatement Strategy Model. In order to apply a source emission strategy, the present value of one or more of the following must be available:

- Source input process material rate
- Source output ACFM capacity

- Present pollutant emission rates for each source
- Present fuel-type being burned for combustion sources
- Thermal capacity of fuel burning plants.

In addition to these data inputs, the Abatement Strategy Model requires a control-card input shown in Table 6-4.

This input selects the sources to be considered for an abatement strategy, the type of strategy, and the degree of control. An option is provided to express process weight or combustion efficiency in terms of a graph with concentrations plotted against tons processed or BTU's of heat input, as shown in the sketch below.



6.6.2 Simulation Mode - Model Outputs

The Abatement Strategy Model outputs are designed so that the user can quantitatively compare the effectiveness of various abatement strategies in a particular region. With the information available from the model

TABLE 6-4. CONTROL CARD INPUT FOR ABATEMENT STRATEGY MODEL

COLS.	DATA	COMMENT
1-4	SIC#	If SIC# is present, only sources in this SIC Group will be processed.
5-8	Beginning Site #	This number indicates the first source of the SIC Group to be processed.
9-12	Ending Site #	This number indicates the last source of the SIC Group to be processed.
13	Source Type	If cols. 1-12 are blank, type indicates 0 - do all sources 1 - do combustion sources only 2 - use previous input sources for the new strategy on this card. When columns 1-12 are not blank, ignore this field.
14	Strategy	Type of strategy to be used with above Groups: 1 - fuel substitution 2 - equivalent fuel sulfur content limitation 3 - process weight regulation 4 - combustion efficiency regulation 5 - maximum technology
15-17	Sulfur content	The sulfur content percentage for strategies 1 and 2.
18	Fuel type	The new fuel types for strategy 1.
19-25	Ordinate	The ordinate value from the pollutant weight output curve for strategies 3 and 4.*
26-32	Abscissa	Abscissa value for above curve.
33-40	Slope	Slope of curve after break.
41-47	Abscissa at break	Abscissa value at point of change from slope.

---

*See Sketch on previous page.

concerning control costs and pollutant concentrations, it should be possible to make rational decisions on air pollution abatement strategies. The information provided by the model should prove valuable in setting preliminary implementation plans aimed at meeting air quality standards.

The cost-effectiveness results for both the region and the individual pollutant emission sources is illustrated in Table 6-5. These results indicate the total regional control cost and the control cost to each SIC code (and site numbered) source for each strategy. In addition, this output provides the effectiveness of the strategy in terms of reducing pollution emission for the whole region as well as for each emission source.

The air quality results of the Abatement Strategy Model are shown in Table 6-6. Each receptor is identified along with its location, the ground-level concentration (after the strategy has been applied), and the concentration value in excess of the air quality standard. A set of punched cards is also provided as an output of ground-level concentration for the contour (SYMAP) plots.

The last set of outputs of the Abatement Strategy Model are the statistical data for 12 selected receptors (Table 6-7). These data are identical in format to the output of the Atmospheric Diffusion Model, and represent the expected condition at selected averaging times following the application of the abatement strategy.

6.7 MODEL OUTPUTS

The Abatement Strategy Model outputs include the following data:

(a) Direct annual control cost to each source

(b) Total regional control cost, based on the application of selected strategies

TABLE 6-5 ABATEMENT STRATEGY COST-EFFECTIVENESS

FUEL SUBSTITUTION STRATEGY SOURCE DATA

SOX REDUCTION 0.01% SULFUR CONTENT

REGIONAL COST = $10.536437 MILLIONS EFFECTIVENESS $12280.71 /TON

REGIONAL EMISSION = 371.870 TONS/DAY REGIONAL REDUCTION 59.76 %

SIC CODE	SITE NO.	DEVICE ID	NEW EMISSION TONS/DAY	DEVICE COST	DEVICE EFFICIENCY	REDUCTION TONS/DAY
2010	900	28	0.978265E 00	$ 59469.	57.47 %	0.132173E 01
2010	910	28	0.216602E 01	$ 131672.	76.07 %	0.688398E 01
2010	920	28	0.210871E 01	$ 128188.	65.32 %	0.397129E 01
2020	2000	28	0.470357E 00	$ 28593.	65.16 %	0.879641E 00
2046	2200	28	0.476014E 01	$ 196672.	74.67 %	0.140298E 02
2082	800	28	0.545458E 00	$ 33158.	65.48 %	0.103454E 01
2082	810	28	0.535133E 01	$ 221098.	70.10 %	0.125486E 02
2082	820	28	0.812257E 00	$ 49377.	74.38 %	0.235774E 01
2800	400	28	0.433178E 01	$ -35604.	57.66 %	0.589822E 01
2800	410	28	0.799378E 01	$ 330275.	70.11 %	0.187462E 02
2800	420	28	0.913048E 00	$ 55504.	65.28 %	0.171695E 01
2800	430	28	0.233578E 01	$ 96506.	70.13 %	0.548422E 01
2819	330	28	0.863437E 01	$	72.75 %	0.230556E 02
2819	340	28	0.626461E		23 %	0.140954E 02
2822	1900	28	0.5138		%	0.160616E 01
2841	2300	28	0.8			0.155588E 01
2911	630	34				870000E 00
3200	1400	28				3406E 01
3210	1210	34				E 01
3312	1100					01
3312	1110					

TABLE 6-6 ABATEMENT STRATEGY AIR QUALITY RESULTS

GROUND LEVEL CONCENTRATIONS

STRATEGY 4 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.750000E 02

RECEPTOR	LOCATION		CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
	X	Y			
1	0.0	0.0	0.319150E-05	0.920402E-06	0.0
2	0.0	15.00	0.352115E-05	0.919404E-06	0.0
3	0.0	30.00	0.362464E-05	0.892014E-06	0.0
4	0.0	45.00	0.404988E-05	0.879846E-06	0.0
5	0.0	60.00	0.420922E-05	0.859535E-06	0.0
6	0.0	75.00	0.504031E-05	0.890363E-06	0.0
7	0.0	90.00	0.456430E-05	0.922829E-06	0.0
8	0.0	105.00	0.438067E-05	0.947147E-06	0.0
9	15.00	0.0	0.403675E-05	0.995143E-06	0.0
10	15.00	15.00	0.450730E-05	0.106528E-05	0.0
11	15.00	30.00	0.476111E-05	0.102846E-05	0.0
12	15.00	45.00	0.532013E-05	0.100151E-05	0.0
13	15.00	60.00	0.554217E-05	0.962686E-06	0.0
14	15.00	75.00	0.576702E-05	0.996984E-06	0.0
15	15.00	90.00	0.569475E-05	0.102334E-05	0.0
16	15.00	105.00	0.543859E-05	0.103065E-05	0.0
17	30.00	0.0	0.512650E-05	0.107772E-05	0.0
18	30.00	15.00	0.584375E-05	0.117220E-05	0.0
19	30.00	30.00	[illegible]	125707E-05	0.0
20	30.00	45.0	[illegible]	5E-05	0.0
21	30.00	[illegible]	[illegible]	[illegible]	0.0
[illegible]	30.00	[illegible]	[illegible]	[illegible]	0.0
	30	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 6-7 ABATEMENT STRATEGY STATISTICAL DATA

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT - PARTICULATE
SEASON - WINTER

AVERAGING TIME 8. HRS. HAS STANDARD DEVIATICN = 2.17

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CCNCENTRATICN	1.0% CONCENTRATION	3.0% CONCENTRATION	5.0% CONCENTRATION
1	7.580203E-07	5.622872E-07	5.C86946E-06	5.086946E-06	5.086946E-06	5.086946E-06
2	1.075715E-06	7.979478E-07	7.218940E-06	7.218940E-06	7.218940E-06	7.218940E-06
3	1.344391E-06	9.972464E-07	9.021971E-06	9.021971E-06	9.021971E-06	9.021971E-06
4	1.619091E-06	1.201015E-06	1.086544E-05	1.086544E-05	1.086544E-05	1.086544E-05
5	1.219570E-06	9.046569E-07	8.184325E-06	8.184325E-06	8.184325E-06	8.184325E-06
6	1.021272E-06	7.575627E-07	6.853580F-06	6.853580E-06	6.853580E-06	6.853580E-06
7	1.575406E-06	1.168610E-C6	1.057227E-05	1.057227E-05	1.057227E-05	1.057227E-05
8	3.907039E-06	2.898177E-06	2.621945E-05	2.621945E-05	2.621945E-05	2.621945E-05
9	4.110050E-06	3.048767E-06	2.758183E-05	2.758183E-05	2.758183E-05	2.758183E-05
10	2.144920E-06	1.591066E-06	1.439419E-05	1.439419E-05	1.439419E-05	1.439419E-05
11	9.175465E-07	6.806210E-07	6.157498E-06	6.157498E-06	6.157498E-06	6.157498E-06
12	1.387619E-06	1.029312E-06	9.312060E-06	9.312060E-06	9.312060E-06	9.312060E-06

(c) Emission of source, following the application of control measures

(d) Contour maps of ground-level concentrations at each receptor point in the region before and after the application of the abatement strategies.

The results presented in the Abatement Strategy Model outputs are used as an indicator for further computer runs. These runs may reflect additional strategies or changes to the values of strategies that have already been exercised (e.g., a change to the sulfur content percentage or the process weight function).

7. REGIONAL ECONOMETRIC MODEL

7.1 PURPOSE

The purpose of the Regional Econometric Model is to provide the RAPA program with a means of assessing economic impacts in a region that may contain industries required to institute air pollution control measures and industries producing air pollution control equipment.

In deciding upon production plans, industries traditionally have not had to consider the external social costs generated by their activities. Were they required to do so, they would notice an increase in the costs of production, perhaps to a prohibitive degree. In particular, industries emitting harmful pollutants into the air during the production process have, by not bearing the cost of the resulting social damage, enjoyed the advantages of lower production costs. With the additional concern for air quality, industries will be encouraged to control the amount of pollutants that they discharge into the air. To industry this means that, for the same amount of output produced prior to consideration of air pollution controls, production costs will be increased as a result of the required investments and operating expenses for air pollution control. Thus, certain economic sectors that in the past have enjoyed the advantages of low-cost production may have to face some degree of economic decline due to the effects of air pollution abatement strategies.

The Regional Econometric Model is designed to provide the following types of information for public-policy analysis:

- Impact analysis of negative regional economic effects upon high-emission industries expected to result from enforcement of varying abatement strategies.

- Impact analysis of the regional economic expansions expected to result from reduction of industrial damage and growth in air-pollution equipment industries.

- Projection of regional output and emission levels of high-emission industries in the future, in the presence of varying abatement strategies.

- Estimation of fiscal effects of regional implementation of abatement strategies, including tax-base impacts of economic change, and the effects of tax credits upon economic changes due to abatement strategies, in terms of the implementation plan.

- Statistical indicators, including industry-specific ratios of air pollution control costs to total investment and to value-added in production.

7.2 DESIGN SUMMARY

The Regional Econometric Model draws upon four basic types of information in its economic estimation process:

- Average annual cost for air pollution control equipment for each abatement strategy, including all initial and on-going costs, annual costs of fuel changes and associated equipment changeover costs, less by-product revenues.

- National industry output data and projections (by two-digit Standard Industrial Classification code).

- Initial-period regional activity level and stock data.

- Regional air quality control strategy variables, such as tax credits.

Given these sets of data, the model produces estimates of regional economic variables, including:

- Gross regional product.

- Employment change by industry (two-digit SIC code).

- Investment change and capital stock by industry.

- Industry value-added.

- Regional tax receipts.
- Regional unemployment.

Figure 7-1 illustrates the basic inputs and outputs of the Regional Econometric Model.

The economic estimates provided by the Regional Econometric Model are flexible to accommodate a variety of air pollution control strategies including those that are currently available, as well as future strategies that are under consideration.

Strategies currently available are the establishment and enforcement of regional air quality standards through source emission standards contained in regional implementation plans. These implementation plans may be thought of as depicting a schedule for achieving air quality standards over a period of time, as illustrated in Figures 7-2a and 7-2b.

One factor in determining the rate of implementation of air quality standards will be the estimated rate at which industry can absorb the cost of air quality control equipment installations. The Regional Econometric Model is designed to provide estimates of such rates for thirteen industrial sectors. In this manner, the model may provide data for facilitating the current process of implementation planning.

The future process of implementation planning may be enhanced by providing States and regional agencies with additional strategies for mounting a set plan. For example, a tax-credit strategy would accelerate the rate at which industry can absorb pollution control costs, and this in turn would increase the rate at which desired standards can be implemented. This effect is illustrated in Figure 7-3.

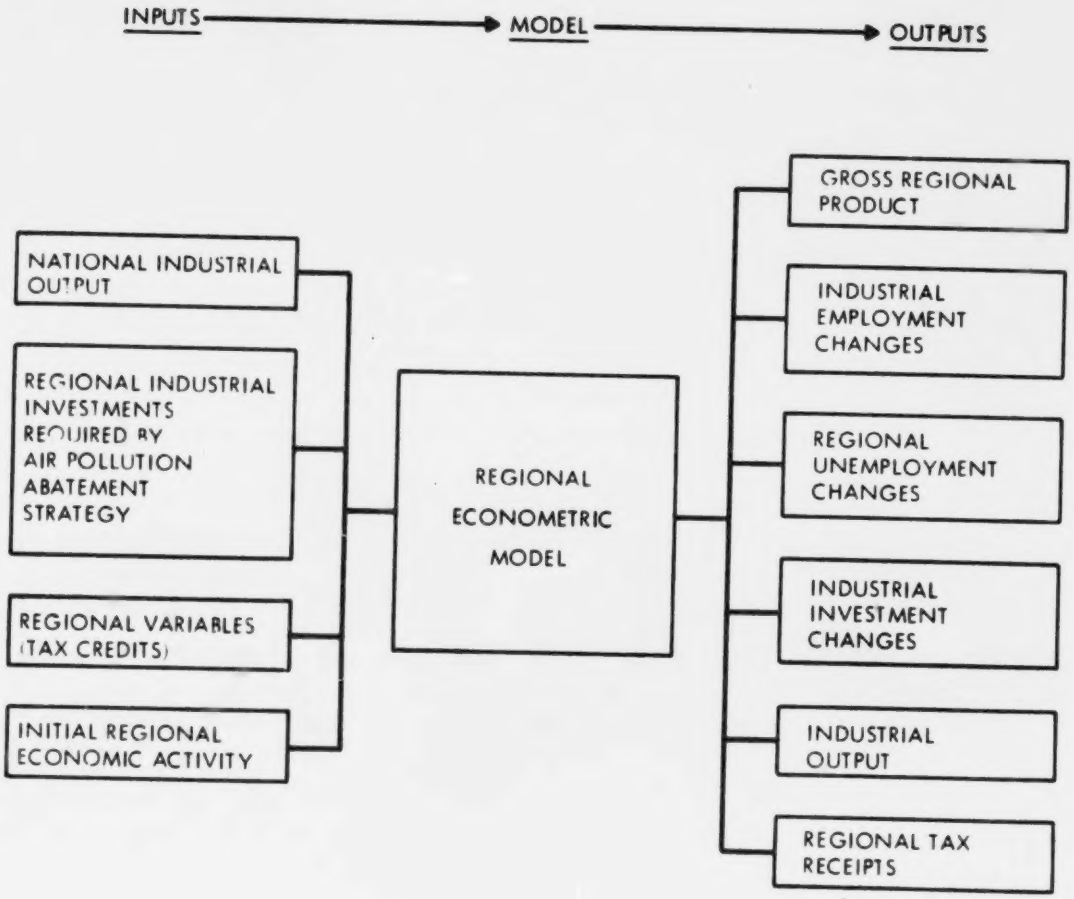

INPUTS
MODEL
OUTPUTS
NATIONAL INDUSTRIAL OUTPUT
REGIONAL INDUSTRIAL INVESTMENTS REQUIRED BY AIR POLLUTION ABATEMENT STRATEGY
REGIONAL VARIABLES (TAX CREDITS)
INITIAL REGIONAL ECONOMIC ACTIVITY
REGIONAL ECONOMETRIC MODEL
GROSS REGIONAL PRODUCT
INDUSTRIAL EMPLOYMENT CHANGES
REGIONAL UNEMPLOYMENT CHANGES
INDUSTRIAL INVESTMENT CHANGES
INDUSTRIAL OUTPUT
REGIONAL TAX RECEIPTS

FIGURE 7-1 Inputs and Outputs of Regional Econometric Model

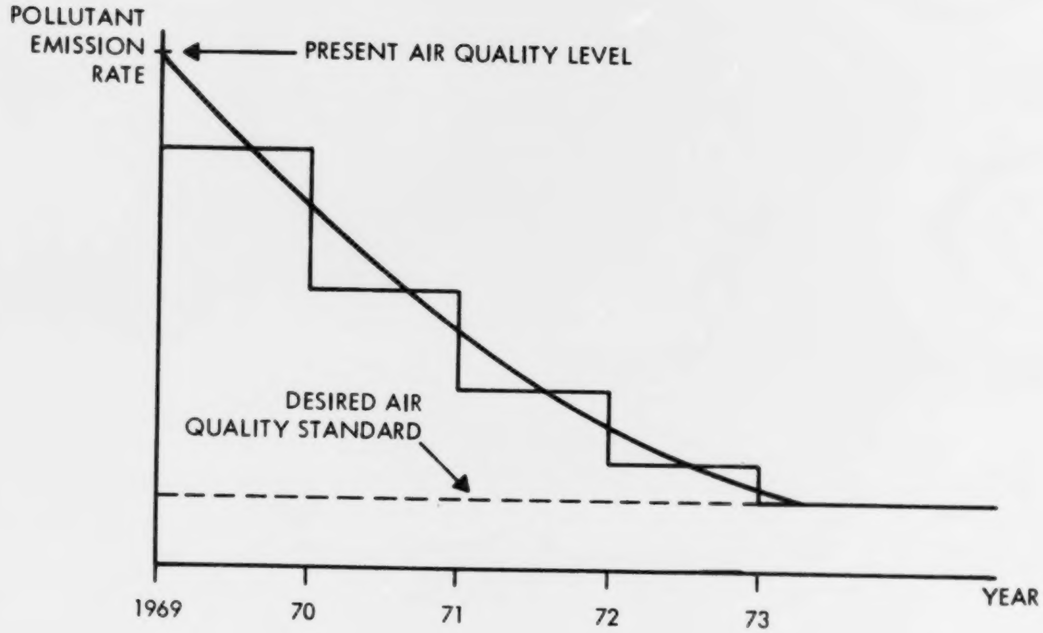


FIGURE 7-2a Rapid Implementation - High Rate of Industrial Cost Absorbtion

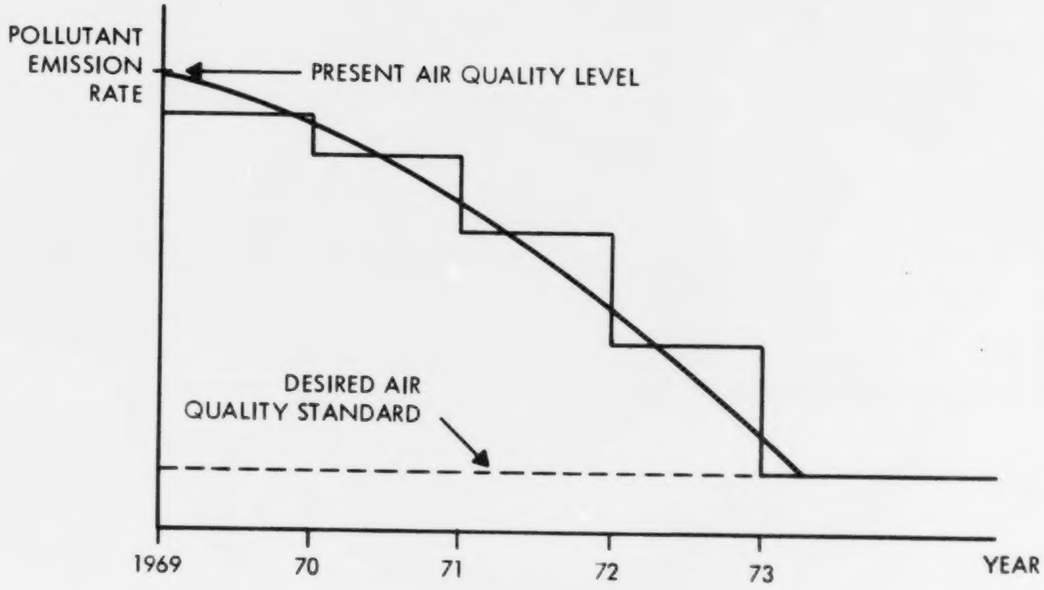


FIGURE 7-2b Gradual Implementation - Low Rate of Industrial Cost Absorbtion

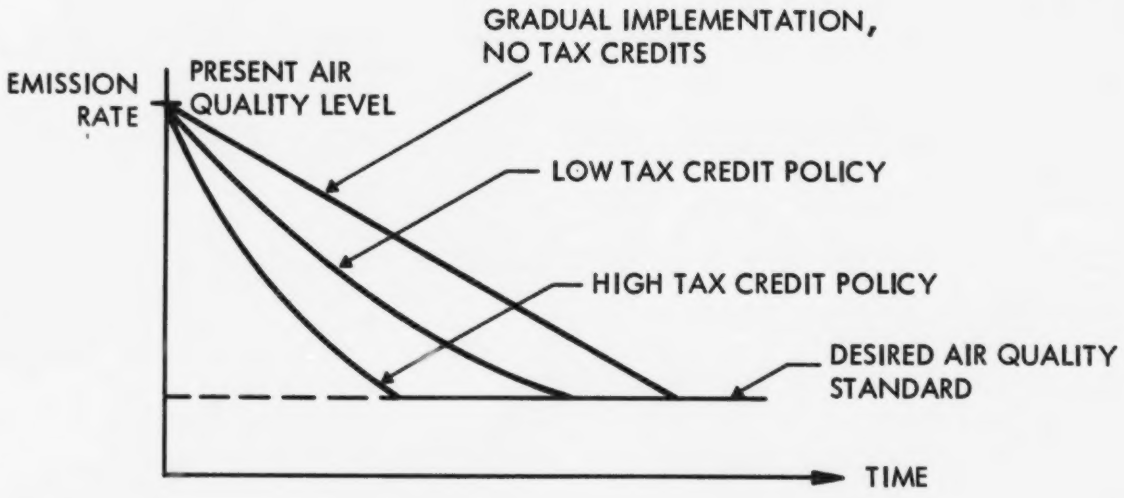


FIGURE 7-3 Effect of Tax Credit Policy Upon Implementation Plans

Although acceleration of a feasible implementation schedule will occur under a tax-credit policy, the effectiveness of this strategy will depend upon the industrial composition of the region. The possible impacts of a proposed tax-credit strategy upon the feasible rate of implementation be estimated with the Regional Econometric Model. The manner in which the model treats these effects is described in the next section.

7.3 MODEL STRUCTURE

The Regional Econometric Model contains over 100 econometric equations which have been calibrated specifically for the seven-county St. Louis Metropolitan region, using time-series data over the period 1954-1966.

The model contains 14 economic sectors, comprised of 13 manufacturing sectors and one service sector. The 13 manufacturing sectors are of three types: high air pollution emission sectors serving the national markets, high air pollution emission sectors serving the local markets, and a non-air pollution emission sector. The high-emission sectors are at the two-digit SIC code level and embrace the specific industries identified in the St. Louis emission source inventory. Sectoring at the two-digit level is dictated by the current availability of time-series data, which does not at this time allow sectoring at the four-digit SIC level. Where the investment behavior of the specific emission industry follows the pattern of the broader two-digit sector of which it is a part, the level of detail presently achieved in the model properly represents reality.

The manufacturing sectors in St. Louis that contain high-emission industries are as follows:

NATIONAL MARKET EMISSION SECTORS

Paper and Pulp	SIC26
Stone, Clay and Glass	SIC32
Primary Metals	SIC33
Chemicals	SIC28
Petroleum and Coal	SIC29

LOCAL MARKET EMISSION SECTOR

Electric Power Utility

The non-emission sectors include the following:

NON-EMISSION MANUFACTURING SECTORS

Food	SIC20
Printing and Publishing	SIC27
Fabricated Metal Products	SIC34
Machinery (except electrical)	SIC35
Electrical Machinery	SIC36
Transportation Equipment	SIC37
Other Manufacturing Industires	

NON-EMISSION SERVICE SECTOR

Sector includes government, retail and consumer services, business services, wholesaling, and construction sectors.

The model processes, which trace the regional economic impacts of air-pollution control, are described in Figure 7-4. All exogenous variables are listed on the left side of the diagram. These include (1) national output trends, and (2) air quality control costs. Among the latter are annualized control-equipment costs, annualized fuel-change costs, and such special control

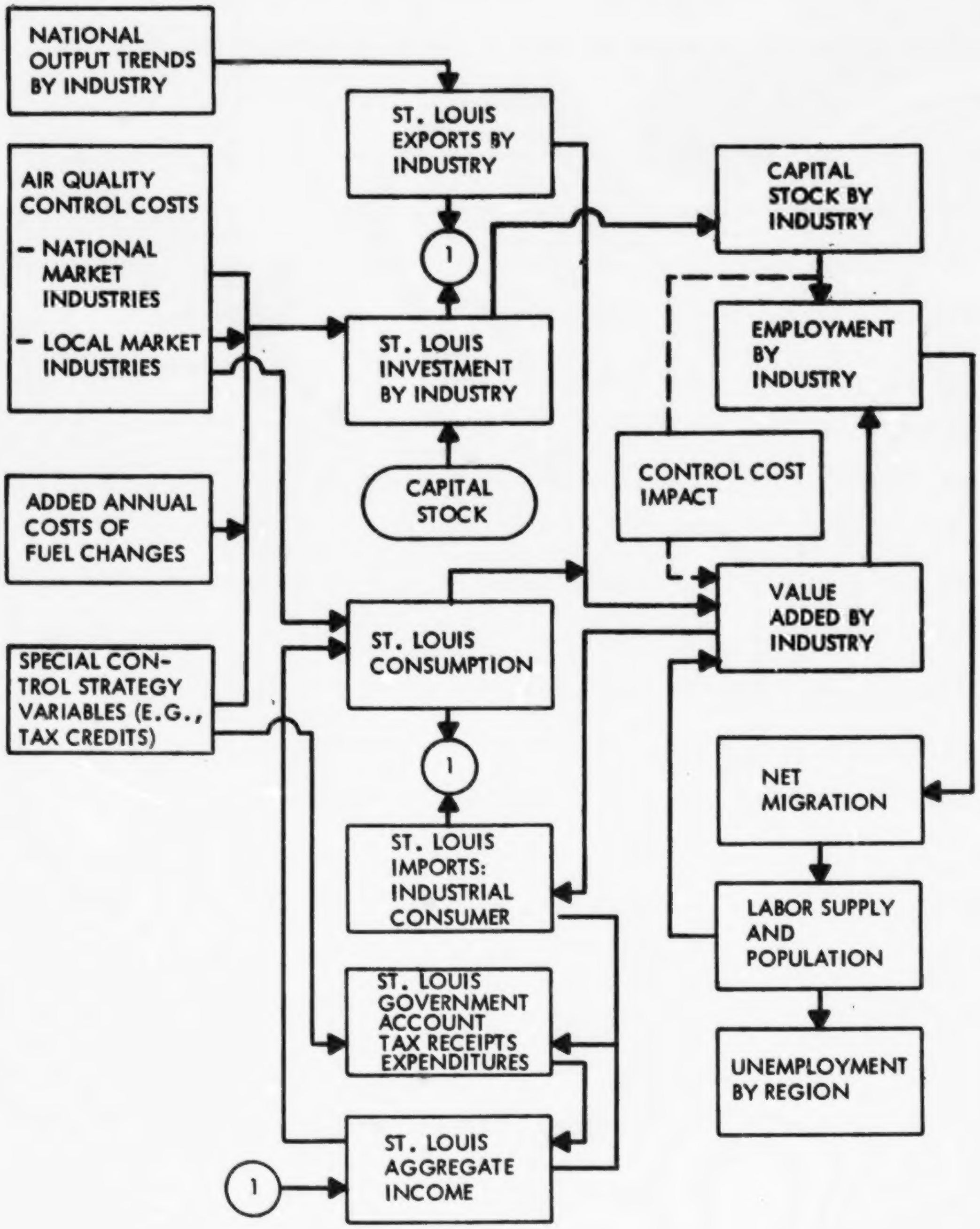

NATIONAL OUTPUT TRENDS BY INDUSTRY
ST. LOUIS EXPORTS BY INDUSTRY
AIR QUALITY CONTROL COSTS
– NATIONAL MARKET INDUSTRIES
– LOCAL MARKET INDUSTRIES
CAPITAL STOCK BY INDUSTRY
1
EMPLOYMENT BY INDUSTRY
ST. LOUIS INVESTMENT BY INDUSTRY
CAPITAL STOCK
CONTROL COST IMPACT
ADDED ANNUAL COSTS OF FUEL CHANGES
VALUE ADDED BY INDUSTRY
ST. LOUIS CONSUMPTION
SPECIAL CONTROL STRATEGY VARIABLES (E.G., TAX CREDITS)
1
NET MIGRATION
ST. LOUIS IMPORTS: INDUSTRIAL CONSUMER
LABOR SUPPLY AND POPULATION
ST. LOUIS GOVERNMENT ACCOUNT TAX RECEIPTS EXPENDITURES
UNEMPLOYMENT BY REGION
1
ST. LOUIS AGGREGATE INCOME

FIGURE 7-4 Regional Econometric Model Structure

strategy variables as tax credits and per capita costs for control of mobile sources, all of which may be made specific to any given level of emission standard.

To use the model for simulating economic impacts of air pollution control strategies, the model first must be executed to predict the time-path of the economy, assuming no air pollution control investment. In this execution, national output determines export demands for St. Louis industry. The level of capital stock and retained earnings in the preceeding year determines the level of investment by St. Louis industry. The scale of industrial and consumer demand determines output in local market industries (electric power, for example); the local prices, in turn, affect industry investment and consumer demands. Export demand determines output and value-added in national market industries, while inter-industry and consumer demands determine output and value-added in local market industries. Employment in each industry then is determined by the level of capital stock, which includes current investment and value-added in each industry. Employment demand, in turn, determines the size of the labor force in St. Louis. Imports, consumption, and government activity depend upon total income. Finally, total export, investment, consumption, import, and government-sector demands are summed to aggregate the St. Louis income.

Once the time-path of economic variables without control investment is plotted, the simulation then may be executed to predict the same variables, assuming alternative levels of control-device or fuel-change costs due to the abatement strategy. In these simulations, investment also is determined by control cost, which affects the level of capital stock. This in turn (as shown by the dotted line in Figure 7-4), affects the level of value-added by industry.

7.4 MODEL EQUATIONS

The description of the structural relations of the model equations starts with a comparison of the developmental process of regional models with several advanced models developed at the national level.* The existing econometric models based on regional units in a nation are still few, their scope much smaller, and the results rather less sophisticated. The reason for such differences can be summarized in three statements.

First, at the national level, nearly-perfect time-series data have been available for all major economic variables, and some variables such as capital stock are even published as the result of inquiry. But at the regional level -- either State or SMSA -- data are often unreliable and unavailable, especially in continuous time-series form.

Second, econometricians began the development of their models at the national level. From time to time, different equations and theories have been tested with the same base of data in a well-defined economy, say the United States. By repetition of tests and the accumulation of experience, models calibrated to good theoretical structures are now available. To the contrary, the geographic area for which regional models are developed usually changes from one application to another. Beyond the uniqueness of data, geographic and cultural environment and socio-economic structure may differ from region to region, resulting in parameters estimated for each model that are difficult to compare.

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*For example, Klein [1964], Klein-Goldbeyer [1955], Suits [1963], Dusenberry and others Dusenberry, [1965, etc.]

Third, theoretically speaking, macro-economic models are usually based on well-established economic theory in their formulation. However, at the regional level, economic base theory, location theory, gravity concepts, and migration theory (especially the concept of "distance" emphasized by regional scientists) are much harder to integrate into an overall hierarchical system.

With such shortcomings, several notable regional models have been estimated recently. For example, Bell [1967] estimated a Massachusetts model. An Alaksan model by Tuck [1967], a Puerto Rico model by Dutta and Su [1965], a Northeast Corridor model by Crow [1967] and Putman [1967], a Michigan model by Suits [1962], a Philadelphia SMSA model by Glickman [1968], and a Hyogo-ken model in Japan by Kaneko [1967] can be indicated. Klien [1968] recently suggested a general strategy for building regional econometric models to link with national models.

For the present regional models, the following characteristics not normally considered in national econometric models must be treated:

(1) National influence upon local economy

(2) Migration patterns

(3) Inter-regional commodity flows

(4) Inter-industrial structure

(5) Function of local government

7.4.1 The Variables of the Model

Y_{Nit} = national income by sector i (\$ million) at time t

E_{it} = export by industry i (\$ million) at time t

V_{it} = value-added by industry i (\$ million) at time t

M_{it} = import by industry i (\$ million) at time t

N_{it} = employment by industry i (x 1000) at time t

K_{it} = capital stock of industry i ($ million) at time t

I_{it} = investment by industry i ($ million) at time t

Π_{it} = capital share of value-added or profit by industry i ($ million) at time t

Q_{it} = electric power demand by industry i (100 kilowatt hours) at time t

For the above variables:

i = SIC #20, 26, 27, 28, 29, 32, 33, 34, 35, 36, 37, and other manufactures. (These SIC numbers identify the 12 manufacturing sectors of the model).

T_t = local tax revenue at time t

G_t = local government expenditure ($ million) at time t

C_t = consumption ($ million) at time t

Y_t^* = $(C_t + \sum_i I_{it} + \sum_i E_{it} - \sum_i M_{it} + G)$ = regional expenditure ($ million) at time t

Y_t = regional income ($ million) at time t

$\bar{N}_t$ = employment by industries other than manufacturing industries (x 1000) at time t

N_t = $(\equiv \sum N_{it} + \bar{N}_t)$ = total employment (X 1000) at time t

L_t = total labor force (x 1000) at time t

u_{Nt} = national unemployment rate (%) at time t

U_t = unemployment (x 1000) at time t

u_t = local unemployment rate (%) at time t

Q_{ct} = electric power demand (x 1000 kilowatt hours) for residential use at time t

$\bar{Q}_t$ = electric power demand (x 1000 kilowatt hours) for non-manufacturing industries at time t

t = time period (1954 = 0, 1955 = 1, 1966 = 12)

P_C = local consumption price index

r = national interest rate

Π = total regional profit or property income

T_1^L = local direct taxes

T_2^L = local indirect taxes

T^F = taxes paid to federal government by the region

T^R = transfer payments

D = depreciation on regional capital stock

X_i = regional gross output by industry i (i=1, ...,n)

P_i = regional price of output i

P_{Ni} = national price of output i

GNP = gross national product

O_i = domestic final demand for regional output i

a_{ij} = input-output coefficient of local economy

W_i = wage ($ x 1000) per man-year for industry i

7.4.2 Structural Equations

As the starting point, the gross regional product identity can be given as

$$Y^* = C + I + E - M + G. \qquad (1)$$

In the right-hand side of this identity, consumption, investment and export always have been emphasized in regional growth models. These three variables determine the regional multiplier effect to regional growth, through the Keynesian type multiplier-acceleration principle or regional export-base theory.

The consumption and investment function can be formulated as:

$$\frac{C}{P_C} = f_2 \left(\frac{Y}{P_C} \right). \qquad (2)$$

$$I = f_3 (K_{t-1}, t, \Pi), \qquad (3)$$

where the consumption function has been presented in real terms as a function of disposable income.

The regional disposable income identity is:

$$Y = X - T_1^L - T_2^L - T^F + T^R - D; \qquad (4)$$

that is, gross regional product after tax (T_1^L, T_2^L, T^F) and depreciation (D) of existing capital stock, plus transfer payments (T^R).

The investment function may be disaggregated into manufacturers and non-manufacturers, or even according to the sectoral structure. However, the general form of Equation (3) will remain in this common form for purposes of discussion.

It has been indicated in Section I that, for a regional model, the export sector usually plays an important role, especially for a relatively small regional unit such as St. Louis SMSA. Trade with "rest-of-the-world" is the key to the economic growth. Meanwhile, regional export may be strongly related to the metropolitan inter-industrial structure. Thomassen [1957], Bell [1967], Glickman [1968], and Klein [1968] link exports with GNP. However, it is most important that the export sector be disaggregated, and that sectoral exports should be taken as a function of both national sectoral output and comparative sectoral prices between the region and the "rest-of-the-world." The reason is that the inter-industrial structure of a large metropolitan area may be quite different from the national level. As has been indicated in location theory, it is a well-known fact that regional source endowments and other socio-economic characteristics determine the industrial structure of a local economic unit. Therefore, the use of a GNP trend is a less desirable indicator of external market demand than national outputs by industry. In general, regional sectoral output (X_i) is a function of local inter-industrial demand (X_j ; j = 1, ...n), national sectoral output (Y_{Ni}), and comparative price (Pi/PNi),

$$X_i = f_5 \left(X_1, \ldots, X_n, Y_{Ni}, \frac{P_i}{P_{Ni}}\right) \quad i=1, \ldots, n. \tag{5}$$

However, such a formulation may face a serious multicollinearity problem upon estimation. A possible solution to this problem is to separate (5) into two equations, namely export demand and domestic demand. Noting that export data is unavailable, residual exports of the ith industry (E_i) can be defined as:

$$E_i = X_i - \sum_{j=n}^{n} a_{ij} X_i - O_i, \quad i=1, \ldots, n, \tag{6}$$

where O_i is domestic final demand of industry i. Equation (6) may be obtained from an output-input table, a technique that has been applied in the recent Brookings' model [Duesenberry, 1965]. For these export-oriented industries, the residual export function will be:

$$E_i = f_7 \; Y_{Ni}\left(\frac{P_i}{P_{Ni}}\right) \quad i=1, \ldots, k, k+1, \ldots m, \tag{7}$$

where the first k industries are high-emission sources.

However, since there is some industry (i = k + 1,...,n) which has a small role in export, we can aggregate into one equation:

$$\sum_{i=k+1}^{n} E_i = E_R \tag{8}$$

$$E_R = f_9 \left(GNP, \frac{P}{P_N}\right). \tag{9}$$

Import may be divided into consumption goods (M_C) and industrial goods (M_I).

$$M = M_C + M_I \tag{10}$$

$$M_C = f_{11}\left(Y, \frac{P_C}{P_{Nc}}\right) \tag{11}$$

$$M_I = f_{12}\left(X, \frac{P}{P_N}\right) \tag{12}$$

Equation (12) can be disaggregated according to export sectors, or Equations (10), (11), and (12) can be aggregated into one equation:

$$M = f\left(\sum_i x_i \frac{P}{P_N}\right) . \tag{10'}$$

The ability to estimate the import function is highly dependent upon availability of data and relations with other equations.

The government sector plays an important role in the regional economy, and therefore must be included in the regional model.

In most of the national models, government expenditures have been treated as exogenous.* Klein [1968] has strongly suggested making them endogenous at the regional level. After a small modification of his proposal, we have:

$$T_1^L = f_{13}(W, \Pi) \tag{13}$$

$$T_2^L = f_{14}(\Sigma X_i) \tag{14}$$

$$T^F = f_{15}(W, \Pi)$$

$$T^R = f_{16}(U, P) \tag{16}$$

$$G = f_{17}(T_1^L + T_2^L, P), \tag{17}$$

---

*The Brookings Model has allowed for endogeneous treatment. See [Dusenberry, 1965]. "Government Revenue and Expenditures," by Ando, A., E.C. Brown and E. W. Adams, Jr.

where direct local taxation (T_1^L) and federal tax (T^F) are functions of wage bill and profit; indirect local tax (T_2^L) is a function of regional output, while transfer payments (T^R) are a function of unemployment and population. Finally, local government expenditures (G) are a function of local taxation and population.

Through the multiplier effect, the mix of expenditures from private and public sectors (effective demand) determines gross regional product; by the same token, level of gross regional product determines the regional employment levels. From our last experience in the EDA labor force model [19], the labor market behavior can be given by the following Equations:

$$N_i = f_{18}(V_i, t, K_i) \quad i = 1, \ldots, n \tag{18}$$

$$L = f_{19}(\sum_i N_i, U_N) \tag{19}$$

$$U = L - \sum_i N_i \tag{20}$$

Employment is a function of output, level of output, and capital stock which can be derived from the production function. Finally, the differences between labor force and employment determine regional unemployment.

7.4.3 Price Effects of Air Pollution Control Costs

7.4.3.1 Air Pollution Control Equipment

a) National-Market Industries

Since price is determined nationally, it is assumed that local nation-serving industries cannot raise prices above the national level. The effect of air-pollution control costs will be to raise unit production costs, output held constant; and clearly, this reduces industry profit. This effect is treated through the investment function:

$$I = f(\overline{\Pi}, K_{t-1}, i)$$

$$\overline{\Pi} = \Pi - \pi_c,$$

where

I = investment

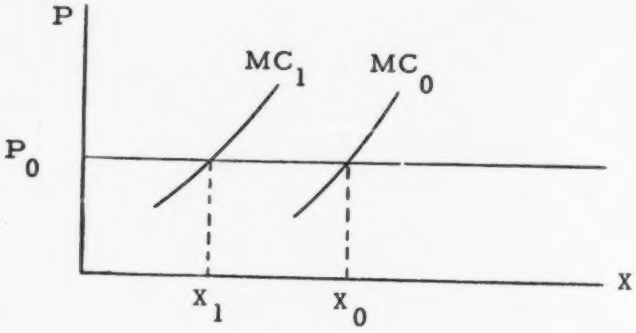
$\overline{\Pi}$ = adjusted return to owners of capital after control equipment outlays

K_{t-1} = capital in the preceding year

i = the interest rate

π_c = the annualized cost of control equipment

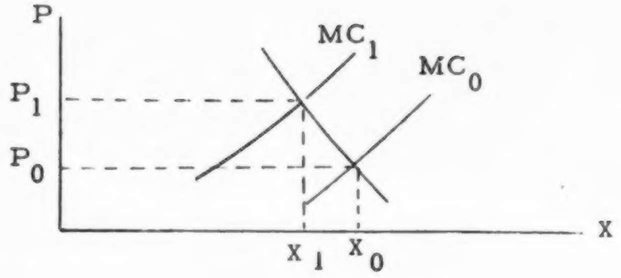
The effect of π_c is to reduce investment, which reduces capital stock. This shifts the industry supply curve, as shown below, to the left from MC_0 to MC_1 with output diminishing from X_o to X_1.



National Market Industry

b) Local Market Industry

Price is determined at the local level, since outside sources do not serve the local market. The industry demand curve is, therefore, relatively unrealistic (below), and changes in local price will not lead to import competition (as is the case in the electric power industry).



Local Market Industry

A substantial increase in production cost, due to air pollution control costs, will lead to a local price (rate) increase. Two types of effects will occur. The first is a reduction of disposable consumer income (Y), the effects of which can be estimated through the consumption function:

$$C = f\,(y - \Delta P_Q\, Q_C),$$

where:

C = consumer expenditures

Q_C = electric power consumption

ΔP_Q = the price rate change

The second effect is an increase in power costs to industry.

This may be treated through the investment functions of industry:

$$I = f(\overline{\Pi}\ ,\ K_{t-1}\ I)$$

$$\overline{\Pi} = \Pi - \Delta P_q Q.$$

The latter identity is obtained through the output functions of industry:

$$PX = \Sigma P_j X_j - P_{Q1} Q\ \Delta P_Q Q = V \equiv \Pi\ wL$$

and

$$PX - \Sigma P_j X_j - P_Q X \equiv \left[\Pi + \Delta P_Q X \right] + wL,$$

giving the bracketed term the definition:

$$\hat{\Pi} = \pi + \Delta P_Q X,$$

where:

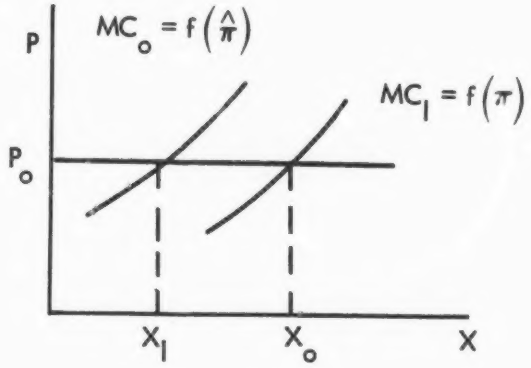
P = output price

X = quantity of output

V = value added

wL = wage bill

Through the output function, it can be seen that a power-rate change will affect the supply price of industry, estimated through the term $\hat{\Pi}$, which results in a decline in output from X_o to X_1, shown below.



National Market Industry

The decline in output, in turn, reduces the demand for power output.

7.4.3.2 Effect of Fuel Changes

Fuel substitution, such as the substitution of low-sulfur coal for high-sulfur coal, and fuel switching, such as from coal to petroleum, will cause an increase in fuel costs to industry. This effect may be estimated, using the same approach used in the case of a power-cost change.

7.5 ESTIMATES OF MODEL PARAMETERS

The model is, except for the income determination block, recursive. Regional income and consumption expenditures are estimated simultaneously, given exports, imports, investments, and government expenditures (the latter a function of tax revenue). In income-determination, the Keynesian type of model usually emphasizes two types of theory: the multiplier-acceleration principle, which is based on the propensity to consume; and the economic-base theory, which emphasizes the role of exports in determining regional income. The present model attempts to absorb these two theories into a one income-determination block in which both exports and consumption play vital roles in income determination. In addition, non-manufacturing employment level is a function of non-manufacturing income; and labor force is determined by total employment and national unemployment rates. The difference between labor force and total employment determines local unemployment. Since the electric-power industry has been considered a major pollutant in the St. Louis SMSA, a set of electric-power demand functions has also been estimated.

A. General form of the export function will be

$$E_{it} = a_i + b_i \, Y_{Nit}. \qquad (1)$$

and with cost of control (signified by an asterisk)

$$E^*_{it} = \frac{K^*_{it}}{K_{it}} \, E_{it}$$

The results of estimation are:

Equation Number	Industry Code	a_i	b_i	R^2	Durbin-Watson Statistic
(1.1)	SIC 20	244.585 (45.371)	.0284 (.00366)	.832	1.713
(1.2)	SIC 26	27.688 (4.163)	.00663 (.000861)	.830	1.697
(1.3)	SIC 27	10.998 (7.128)	.0152 (.00104)	.947	.534
(1.4)	SIC 28	-4.462 (22.090)	.0664 (.00230)	.986	2.295
(1.5)	SIC 29	-344.071 (86.110)	.124 (.0183)	.789	2.55
(1.6)	SIC 32	21.522 (10.528)	.0151 (.00222)	.791	.772
(1.7)	SIC 33	-144.539 (83.865)	.0435 (.00716)	.750	2.218
(1.8)	SIC 34	55.472 (12.206)	.0155 (.00136)	.915	2.064
(1.9)	SIC 35	93.853 (7.792)	.0105 (.000574)	.965	2.105
(1.10)	SIC 36	141.997 (18.689)	.00539 (1.00169)	.435	1.079
(1.11)	SIC 37	468.752 (88.511)	.130 (.00945)	.940	1.812
(1.12)	Other Manu.	230.314 (19.383)	.003181 (.527)	.747	2.517
All Manufacturing Ind.		-176.337 (181.595)	29.527 (1.351)	.975	1.287

In addition to the high degree of correlation (R^2) shown in this table, Figure 7-5 illustrates an example of the similarity between actual data and data calculated by the model. The figure represents export dollars for all industries with no air pollution control investments between 1954 and 1966.

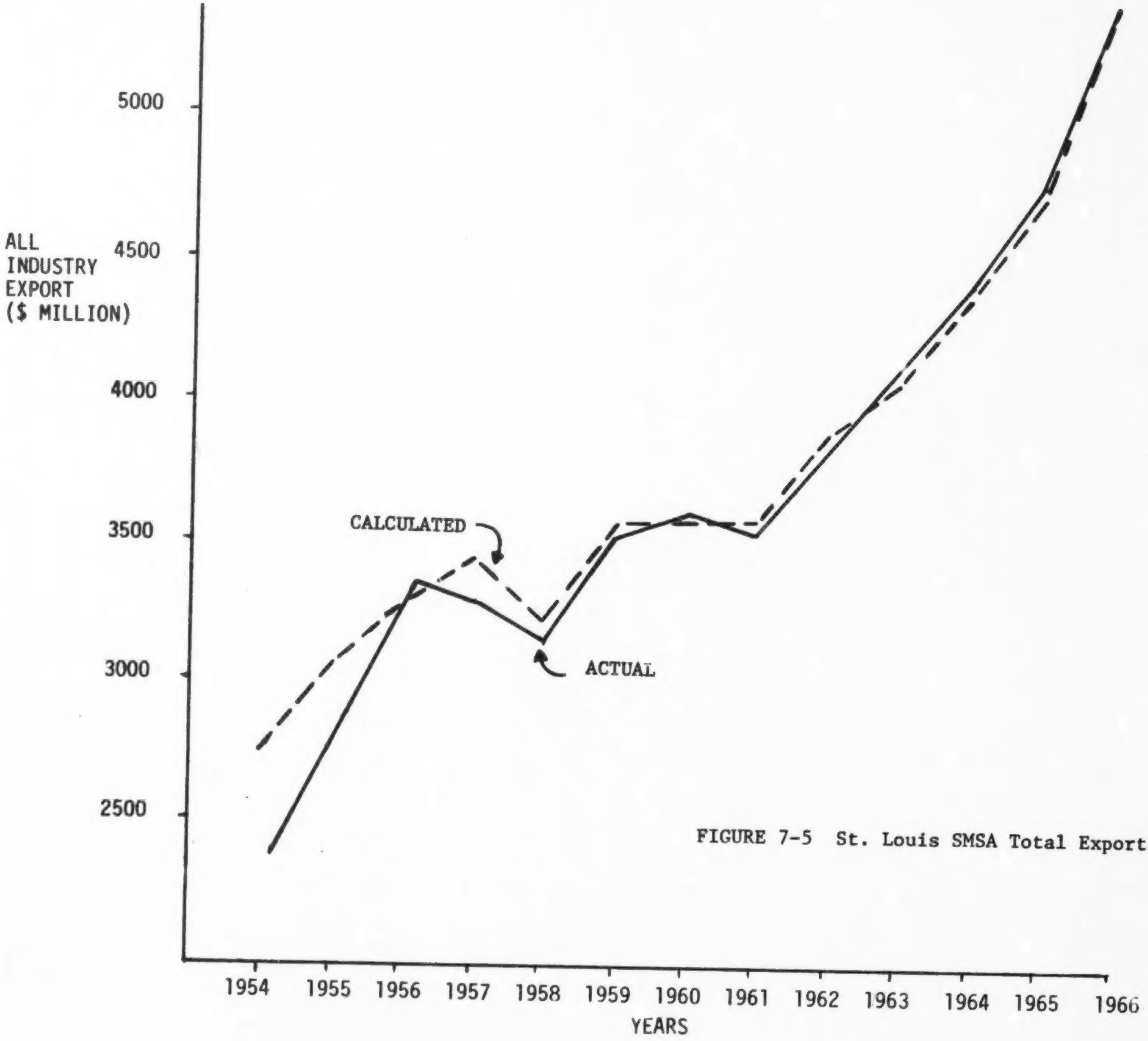


FIGURE 7-5 St. Louis SMSA Total Exports

B. Commodity Demand Function

$$V_{it} = a_i E_{it} \tag{2}$$

This is a set of identities expressing the proportionalities between exports and value-added of corresponding manufacturing industries. The a_i's have been obtained from the St. Louis input-output table.*

When the model is used to simulate the impact of air pollution control costs upon the St. Louis economy, value-added is to be derived in terms of both export demands and the ratio of the level of capital stock, given control costs, to the level that would have occurred without control costs:

$$V^*_{it} = \frac{K^*_{it}}{K_{it}} a_i E^*_{it} \tag{2'}$$

Equation Number	Industry Code	a_i
(2.1)	SIC 20	.639
(2.2)	SIC 26	1.143
(2.3)	SIC 27	1.143
(2.4)	SIC 28	.553
(2.5)	SIC 29	.553
(2.6)	SIC 32	1.320
(2.7)	SIC 33	.688
(2.8)	SIC 34	.972
(2.9)	SIC 35	.781
(2.10)	SIC 36	.708

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*Ben-Chieh Lier, Interindustrial Structure Analysis: An Input-Output Study of the St. Louis Region, 1967, St. Louis Regional Industrial Development Corp., 1968.

Equation Number	Industry Code	a_i
(2.11)	SIC 37	.809
(2.12)	Other Manu.	.949

C. Import demand function:

$$M_{it} = a_i V_{it} \tag{3}$$

The levels of manufacturing industry output determine the imports of raw materials and intermediate goods from other regions. Import coefficients (a_i) also were obtained from the St. Louis input-output table.

Equation Number	Industry Code	a_i
(3.1)	SIC 20	.661
(3.2)	SIC 26	.285
(3.3)	SIC 27	.285
(3.4)	SIC 28	.907
(3.5)	SIC 29	.907
(3.6)	SIC 32	.329
(3.7)	SIC 33	.605
(3.8)	SIC 34	.391
(3.9)	SIC 35	.342
(3.10)	SIC 36	.548
(3 11)	SIC 37	1.567
(3.12)	Other Manu.	.501

D. Production function with price index adjustment factor:

$$N_{it} = (\beta_i V_{it})/W_{it} \text{ (See Sec. T for definition of } W_{it}\text{)}, \qquad (4)$$

where β_i has been calculated as the geometric mean of annual St. Louis labor share.

E. Capital share (profit) relation:

$$\Pi_{it} \equiv (1- \beta_i) V_{it} \quad . \qquad (5)$$

Given the Cobb-Douglas production function, capital share or profit in the broad sense can be derived; and the coefficients can be obtained in the

Equation Number	Industrial Code	β_i	$(1 - \beta_i)$	R^2	D-W Stat.
(5.1)	SIC 20	.450	.550	.711	1.629
(5.2)	SIC 26	.581	.419	.821	.955
(5.3)	SIC 27	.617	.383	.914	.847
(5.4)	SIC 28	.319	.681	.974	2.120
(5.5)	SIC 29	.316	.684	.159	.777
(5.6)	SIC 32	.4[illegible]0	.560	.908	1.0818
(5.7)	SIC 33	.580	.420	.841	1.735
(5.8)	SIC 34	.588	.412	.906	1.178
(5.9)	SIC 35	.577	.423	.856	.829
(5.10)	SIC 36	.586	.414	.328	1.228
(5.11)	SIC 37	.501	.499	.957	2.338
(5.12)	Other Manu.	.848	.152	.560	2.478
All Manufacturing Industry		.528	.472	.969	.942

previous table for the production function. All together, there are 12 equations (5.1) - (5.12).

In addition, to consider the effect of air pollution control costs (C) upon industry investment, a modification of Equation (5) is required:

$$\Pi^*_{it} \equiv \Pi_i - C_i \qquad (5')$$

F. Investment Function

The investment functions presented here are rather unique as compared with other equations. The reasons are that, first, investment functions are different from model to model because there are different theories behind each model (usually involving a lag structure)* and, second, investment behavior differs from industry to industry and has basically non-linear relations. Therefore, the results have been presented individually.

$$I_{20t} = 73.865 + .261\Pi_{20t} - .421\ K_{20t-1} \qquad R^2 = .443 \quad (6.1)$$

$$\quad (2.031) \quad (3.27) \quad (2.38) \qquad D\text{-}W = 2.131$$

$$I_{26t} = 1.250 + 3.861\ \delta_t + .0648\Pi_t + .321\ t \qquad R^2 = .844 \quad (6.2)$$

$$\quad (2.768)\ (.811) \quad (.104) \quad (.0763) \qquad D\text{-}W = 2.131$$

where $\delta = 1$, when $t = 7$; otherwise $\delta = 0$

$$I_{27t} = 11.672 + .0983\Pi_{27t} - .235K_{27(t-1)} + 7.927\delta \qquad R^2 = .637 \quad (6.3)$$

$$\quad (14.910)\ (.321) \quad (.562) \quad (3.911) \qquad D\text{-}W = 2.881$$

where $\delta = 1$, when $t = 8, 9, 10$; otherwise $\delta = 0$

$$I_{28t} = 10.222 + .114\Pi - .0394K_{28t-1} \qquad R^2 = .440 \quad (6.4)$$

$$\quad (.0849) \quad (1.328)\ (.086) \qquad D\text{-}W = 2.013$$

---

*For example, ses Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," Econometrica, 1965, pp. 178-96.

$$I_{29t} = 51.01 + .291\Pi_{29t} - .236K_{29t-1} \qquad R^2 = .239 \quad (6.5)$$

D-W = 1.62

(1.04) (1.78) (1.24)

$$I_{32t} = 174.52 + .0486\Pi - 1.424\ K_{32t-1} \qquad R^2 = .353 \quad (6.6)$$

D-W = 2.615

(2.268) (.417) (2.348)

$$I_{33t} = 146.13 + .347\Pi_{33t} - .767K_{33t-1} + 9.788t \qquad R^2 = .685 \quad (6.7)$$

D-W = 2.425

(1.22) (2.84) (1.33) (1.755)

$$I_{34t} = -3.950 + .164\Pi_{34t} \qquad R^2 = .622 \quad (6.8)$$

D-W = 1.854

(2.794) (.0359)

$$I_{35t} = 29.697 + .0829\Pi_{35t} - .369K_{35t-1} + 5.301\,\delta \qquad R^2 = .709 \quad (6.9)$$

D-W = 2.260

(26.549) (.132) (.236) (2.165)

$$+ 1.317t$$

(.889)

where $\delta = 1$, when $t = 4, 5, 6, 7$; otherwise $\delta = 0$

$$I_{36t} = -.553 + .0750\Pi_t + 4.497\delta_t + .169T \qquad R^2 = .709 \quad (6.10)$$

D-W = 1.783

(1.838) (.0311) (1.0527) (.0790)

where $\delta = 1$, when $t = 8$; otherwise $\delta = 0$

$$I_{37t} = 66.549 + .166\Pi_{37t} - .476K_{37t-1} \qquad R^2 = .589 \quad (6.11)$$

D-W = 1.911

(2.05) (3.40) (2.01)

$$I_{other} = -.0919 + .0635\Pi_{other} + .685t \qquad R^2 = .500$$

D-W = 2.89

(11.111) (.256) (.342)

$$\sum_i I_i = 618.82 - .424 \sum_i K_{it-1} + .307\sum_i \Pi_i \qquad R^2 = .906$$

D-W = 2.89

(457.33) (.275) (.007)

G. Capital stock identity:

$$K_{it} \equiv K_{i,t-1} + I_{it} - d_i\, K_{it}, \qquad (7)$$

where d_i is depreciation rate for building and equipment.

Equation Number	Industry Code	Depreciation Rate d_i
(7.1)	SIC 20	.0674
(7.2)	SIC 26	.0534
(7.3)	SIC 27	.0686
(7.4)	SIC 28	.0669
(7.5)	SIC 29	.0614
(7.6)	SIC 32	.0646
(7.7)	SIC 33	.0560
(7.8)	SIC 34	.0700
(7.9)	SIC 35	.0722
(7.10)	SIC 36	.0738
(7.11)	SIC 37	.0784
(7.12)	Other Manu.	.0751

H. Government expenditure equation:

$$\underset{(15.978)}{G_t = 27.517} + \underset{(.0529)}{.951\, T_t} \qquad R^2 = .973 \quad (8)$$

I. Regional expenditures:

$$Y^*_t \equiv C_t + \sum_i I_{it} + \sum_i E_{it} - \sum_i M_{it} + G_t \quad (9)$$

J. Consumption function:

$$\underset{(467.215)}{C_t \equiv 287.524} + \underset{(.0797)}{.592 Y^*_t} \qquad R^2 = .857 \quad (10)$$

$$\text{D-W } d = .882$$

Equation (10) has been estimated by a two-stage least-square method.

K. Relation between regional expenditure Y* and regional income Y.

$$Y_t = -3667.206 + 1.565\, Y_t^* \qquad R^2 = .989 \quad (11)$$
$$(310.85) \quad (.053) \qquad \text{D-W } d = 2.06$$

L. Employment by industries other than manufacturing industries.

$$\overline{N}_t = 384.798 + .0821\,(Y_t - \sum_i V_{it}) \qquad R^2 = .793 \quad (12)$$
$$(37.88) \quad (.0146) \qquad \text{D-W } d = 2.19$$

M. Total employment:

$$N_t \equiv \sum_i N_{it} + \overline{N}_t \qquad (13)$$

N. Labor force function:

$$L_t = 68.01 + .938\, N + 5.366\, u_{NT} \qquad R^2 = .995 \quad (14)$$
$$(63.74) \quad (.0539) \quad (3.427) \qquad \text{D-W } d = 1.18$$

O. Regional unemployment:

$$U_t \equiv L_t - N_t \qquad (15)$$

P. Regional unemployment rate:

$$U_t \equiv U_t/L_t \times 100 \qquad (16)$$

Q. Electric-power demand functions for manufacturing industries:

$$Q_{it} = a_i + b_i\, V_{it} + c_i t \qquad (17)$$

Equation Number	Industry Code	a_i	b_i	c_i	R^2	D-W d
(17.1)	SIC 20	-39.302 (71.82)	.5970 (.2054)	8.171 (1.974)	.937	1.975
(17.2)	SIC 26	$-6.706 + 44.12d + .2978V_{26t}$ (12.46) (1.95) (.204) $+ 5.758t$ (.449) where $d = 1$ if $t < 6$; $d = 0$ if $t \geq 6$			.984	2.41
(17.3)	SIC 27	-11.361 (1.586)	.4063 (.7791)		.857	1.259
(17.4)	SIC 28	79.910 (.919)	.3252 (.0495)	38.992 (2.781)	.914	.906
(17.5)	SIC 29	120.806 (10.103)	.2672 (.1935)	21.031 (15.450)	.975	1.944
(17.6)	SIC 32	160.527 (.837)	1.0533 (.0558)	7.424 (.296)	.450	.806
(17.7)	SIC 33	-65.049 (1.814)	1.3238 (.4963)	2.505	.787	1.823
(17.8)	SIC 34	58.124 (1.814)	.8176 (.4963)		.703	.521
(17.9)	SIC 35	24.652 (2.955)	.1070 (.2430)		.329	1.475
(17.10)	SIC 36	19.996 (.692)	.7681 (.4305)	-1.450 (1.750)	.623	2.296
(17.11)	SIC 37	24.206 (1.10)	.4236 (.3925)	8.095 (1.180)	.972	1.925
(17.12)	Other Manu.	-294.34 (287.8)	2.178 (.0966)	1.665 (8.516)	.555	1.443
All Manufacturing		-633.620 (193.74)	1.1356 (.861)	13.410 (13.693)	.993	1.976

R. Electric-power demand function for residential users:

$$Q_{ct} = -1548.94 + .948\ C_t \qquad R^2 = .972 \qquad (18)$$
$$(201.75) \quad (.0538)$$

S. Electric-power demand function of industries other than manufacturing industries.

$$\overline{Q}_t = 479.98 + 4.552\ (Y_t - \Sigma\ V_{it}) \qquad R^2 = .895 \qquad (19)$$
$$(129.36)\ (.0516) \qquad \text{D-W } d = 1.8$$

T. Wage function. Collective bargaining power also should be included in the model for wage determination.

$$w_{it} = w_{io}\ a_i^{\ t}, \qquad (20)$$

where w_{io} is wage (per man-year) at 1954 by industry i.

Equation Number	Industry Code	w_{io} (\$1000)	a_i	R^2
(20.1)	SIC 20	4.505	1.0413	.996
(20.2)	SIC 26	3.918	1.0407	.991
(20.3)	SIC 27	4.744	1.0343	.990
(20.4)	SIC 28	4.641	1.0422	.998
(20.5)	SIC 29	5.181	1.0409	.993
(20.6)	SIC 32	4.062	1.0461	.986
(20.7)	SIC 33	4.509	1.0474	.988
(20.8)	SIC 34	4.211	1.0430	.995
(20.10)	SIC 36	4.305	1.0323	.994
(20.11)	SIC 37	4.662	1.0519	.995
(20.12)	Other Manu.	3.283	1.0562	.986

7.6 MODEL CALIBRATION DATA

The model requires a considerable array of data for estimating the parameters of the equations. With few exceptions, the list of variables describes the data requirements. In certain cases, however, additional data has been required. All such cases arise from a decision to use estimation techniques other than least-square regression. For example, estimation of the exponents of the production functions requires data on the wage bill and returns to owners of capital, with the exponents of labor and capital being the harmonic means of the wage share and capital share of value-added, respectively. The list of data and the data sources used for calibrating the model are stated on the following pages.

7.6.1 Time Series Data for the St. Louis SMSA

1. National variables:

GNP = gross national product 1947-1967
Q-AN = national agriculture product 1947-1966
Q-MN = national manufacturing product 1947-1966
P-WN = national wholesale price index 1947-1967
P-CN = national consumer price index 1947-1967
P-IN = national industrial commodity price index 1947-1967
R = interest rate (average rate on short term bank loans to business) 1947-1967
W-AN = national agriculture wage rate 1947-1967
W-NAM = national non-agriculture wage rate 1947-1967
W-MN = national manufacturing wage rate 1947-1967
L/P-N = national labor-force population ratio % 1947-1967
U/L-N = % national unemployment 1947-1967

Source: Economic Report of the President, Washington, D.C., U.S. Government Printing Office, 1968.

2. Regional variables:

(a) From City Government Finances (annual publication). The following data have been collected for St. Louis city from 1947-1966.

G-REV = general revenue

G-FR = revenue from state and federal government

T = local tax revenue ($T = T_1 + T_2 + T_3$)

T-L1 = local property-tax revenue (T_1)

T-L2 = local sales tax, etc. (T_2)

T-L3 = other income (T_3)

G-EXP = general expenditure

(b) From *Census of Manufacturers* and *Annual Survey of Manufactures*. The following data have been collected for St. Louis SMSA in 1947, 1954, 1958-1966.

X-M = value-added by manufacturing industry in St. Louis SMSA

I-M = new investment by manufacturing industry in St. Louis SMSA

WB-M = wage bill by manufacturing industry in St. Louis SMSA

N-M = employment by manufacturing industry in St. Louis SMSA

X-M1 = value-added by major air polluting manufacturing industry in St. Louis SMSA

I-M1 = new investment by major air polluting manufacturing industry in St. Louis SMSA

WB-M1 = wage bill by major air polluting manufacturing industry in St. Louis SMSA

N-MI = employment by major air polluting manufacturing industry in St. Louis SMSA.

X-M2 = value-added by other manufacturing industry in St. Louis SMSA

I-M2 = new investment by other manufacturing industry in St. Louis SMSA

WB-M2 = wage bill by other manufacturing in St. Louis SMSA

N-M2 = employment by other manufacturing industry in St. Louis SMSA

(c) From Employment and Earnings Statistics for States and Area, 1939-1966. The following data have been collected for St. Louis SMSA.

N-NA = employment by non-agriculture industries 1958-1966

N-M = employment by manufacturing industry 1958-1966

W-M = wage rate by manufacturing industry 1958-1966

N-GF = employment by Federal government in St. Louis 1959-1966

N-GL = state and local employment in St. Louis SMSA 1959-1966

(d) Statistical Abstract of the United States and Handbook of Labor Statistics, (1967).

P-C = consumer price index in St. Louis 1947-1967

(e) From Area Trends in Employment and Unemployment (monthly publication by Bureau of Employment Security 1956-1967).

L = work force 1960-1967 St. Louis SMSA

U = unemployment 1960-1967 St. Louis SMSA

N = employment 1960-1967 St. Louis SMSA

N-NA = non-agriculture employment 1960-1967 St. Louis SMSA

N-M = manufacturing employment 1960-1967 St. Louis SMSA

U/L = unemployment rate (%) 1960-1967 St. Louis SMSA

(f) From Census of Government Volume III Compendium of Public Employment, 1962. Detailed data of government sector for St. Louis SMSA and corresponding counties has been collected in order to compare with data from source(a).

(g) From Current Population Report, Series P-25, No. 330; Population Estimates, P-23, No. 23; Technical Studies, P-25, No. 137, and Quarterly Summary of State and Local Tax Return, (1965-1968).

POP = population in St. Louis SMSA 1960-1966

POP1 = population in St. Louis City 1960-1966

POP2 = population in St. Louis Surburb 1960-1966

MIG = net migration from St. Louis SMSA 1961-1966

MIG1 = net migration from St. Louis City 1961-1966

MIG2 = net migration from St. Louis Surburb 1961-1966

(h) From County Business Patterns (1947, 1951, 1953, 1956, 1959, 1962, 1964-1967). The following data have been collected for six counties and one city in St. Louis SMSA.

N = total employment

N-M = employment by manufacturing industry

WB = total wage bill in first quarter (January-March)

WB-M = wage bill by manufacturing industry (first quarter, January-March)

N-M1 = employment by major air polluting industry

WB-M1 = wage bill by major air polluting industry (first quarter)

(i) From Individual Income Tax Returns.

Y = gross income (adjusted) for St. Louis SMSA 1959, 1961, 1963, 1965

SW = salaries and wages income for St. Louis SMSA 1959, 1961, 1963, 1965

$\Pi 1$ = net profit income from business for St. Louis SMSA 1959, 1961, 1963, 1965

$\Pi 2$ = other capital income for St. Louis SMSA 1959, 1961, 1963, 1965

(j) From County and City Data Book.

X-R = total retail trade sales in St. Louis SMSA 1954, 1958, 1963

WB-R = wage bill for retail trade in St. Louis SMSA 1954, 1958, 1963

X-S = total receipts from selected service in St. Louis SMSA 1954, 1958, 1963

X-MI = value-added by mineral industry in St. Louis SMSA 1954, 1958, 1963

WB-MI = wage bill by mineral industry in St. Louis SMSA 1954, 1958, 1963

I-MI = capital investment by mineral industry in St. Louis SMSA 1954, 1958, 1963

X-A = agriculture product in St. Louis SMSA, 1949, 1954, 1959, 1964

(k) From State Tax Collection, State Finance Series GF No. 1, state tax revenue by type of tax has been collected.

7.6.2 Cross-Section and Time Series Data for 20 SMSA's

01 Atlanta SMSA
02 Baltimore SMSA
03 Boston SMSA
04 Buffalo SMSA
05 Cincinnati SMSA
06 Cleveland SMSA
07 Dallas SMSA
08 Detroit SMSA
09 Houston SMSA
10 Kansas City SMSA
11 Milwaukee SMSA
12 Minneapolis-St. Paul SMSA
13 New Orleans SMSA
14 Philadelphia SMSA
15 Pittsburgh SMSA
16 St. Louis
17 San Diego SMSA
18 San Francisco SMSA
19 Seattle SMSA
20 Washington, D.C., SMSA

The data including the following items for 1958, 1963, and 1965:

(a) X-M = value-added by all manufacturing industry in each SMSA

(b) X-M1 = value-added by major air polluting manufacturing industry in each SMSA

(c) X-M1 = value-added by other manufacturing industry in each SMSA

(d) I-M = investment by all manufacturing industry in each SMSA

(e) I-M1 = investment by major air polluting manufacturing in each SMSA

(f) I-M2 = investment by other manufacturing industry in each SMSA

(g) WB-M = wage bill by all manufacturing industry in each SMSA

(h) WB-M1 = wage bill by major air polluting manufacturing industry in each SMSA

(i) WB-M2 = wage bill by other manufacturing industry in each SMSA

(j) N-M = employment by all manufacturing industry in each SMSA

(k) N-M1 = employment by major air polluting manufacturing industry in each SMSA

(l) N-M2 = employment by other manufacturing industry in each SMSA

Total population in 1961, 1963, 1965; gross income in 1959, 1961, 1963 and 1965; retail trade sales and payrolls, total receipts of selected services in 1958 and 1963; and unemployment for 1960, 1961, 1963, 1965, also have been collected.

7.7 COMPUTER MODEL

The Regional Econometric Model has been programmed for a general-purpose computer as an integral part of the RAPA program.

An outline of the computational procedure is as follows:

1. (1) The year (represented by T) is established.
2. (2) Those quantities that depend upon T are read in.
3. (3) The parameters that are to have their values calculated for each industry are computed; SUBROUTINE IVALUE is called to compute one of these.
4. (4) Local government expenditure is calculated. SUBROUTINE NODEM is then called in order to combine the individual parameters of (3), obtaining regional data.
5. (5) Values from (3) and (4) are printed out.
6. (6) Steps (3) through (5) are then repeated using equations that employ cost of control measures.
7. (7) If data for another year is to be computed, T is reset and the program returns to step (2). If not, the program terminates.

The program is written in FORTRAN IV, for the IBM 360/40 computer, operating under OS with 32K words of storage. Run time is approximately 2 minutes per case.

7.7.1 Program Specification

Purpose: For a given year, specified by T,

(1) Compute regional income and consumption expenditures for each of 12 major manufacturing categories in the St. Louis area, without incorporating air pollution control costs in the equations.

(2) Compute these quantities again, this time including the control costs, in order to determine effect of this cost on the manufacturing industries involved.

Needed to obtain this information are exports, imports, investments, and government expenditures (the latter a function of tax revenue). Using given input data, these will be computed within the program.

The 12 major manufacturing categories are as follows:

Industry I = 1 is Food and Kindred Products
I = 2 is Paper and Allied Products
I = 3 is Printing and Publishing
I = 4 is Chemical and Allied Products
I = 5 is Petroleum and Coal Products
I = 6 is Stone, Clay and Glass Products
I = 7 is Primary Metal Industries
I = 8 is Fabricated Metal Products
I = 9 is Machinery, except Electrical
I = 10 is Electrical Machinery
I = 11 is Transportation Equipment
I = 12 is Other Manufacturing Industries

Input:

T = year for which quantities are being computed, with

T = 0 denoting 1954

T = 1 denoting 1955, etc.

YN(I) = national income by sector I ($million)

K(I) at time T-1 = capital stock of industry for the year T-1 ($million)

CAPITAL T = local tax revenue ($million)

UN = national unemployment rate (percentage)

COC(I) = control cost for industry I

NOTE: There is an option in this program to compute the variables for a sequence of years; "INIT" denotes first year (T) to be considered, "LAST" denotes the last, and "INCRT" is the increment between years.

Output:

G = local government expenditure ($million)

C = consumption ($million)

Y* = regional expenditure ($million)

Y = regional income ($million)

N-BAR = employment by industries other than manyfacturing industries (1000)

N = total employment (1000)

L = total labor force (1000)

U = unemployment (1000)

SMALL U = Local employment rate (percent)

QC = electric-power demand for residential use (1000 kilowatt hours)

Q-BAR = electric-power demand for non-manufacturing industries (1000 kilowatt hours)

W(I) = wage per man-year by industry I ($thousand)

To obtain these desired quantities, the following are computed and printed out for I = 1,...,12

E(I) = export by industry I ($million)

V(I) = value-added by industry I ($million)

M(I) = Import by industry I ($million)

K(I) = Capital stock of industry I ($million)

I(I) = investment of industry I ($million)

P(I) = Capital share of value-added or profit by industry I ($million)

Q(I) = electric-power demand by industry I (1000 kilowatt hours)

N(I) = employment by industry I (1000)

Procedure:

(1) Set time = T.

(2) Read and write input values that depend on T.

(3) Compute variables of model without cost control factor.

(4) Write out these variables.

(5) Recompute certain of these variables using cost control factor.

(6) Write out these variables.

(7) Change T if desired, and repeat from (3).

If no change is desired, end program.

Subroutines Called:

IVALUE(XI,PI,XKTPRE,T,XT,V)

NODEM(XI,E,XM,G,V,XN,UN,YSTAR,XC,YREG,SNBAR,SNTOT,XL,U,XLU,QC,QBAR)

7.7.2 Subroutine Specification

(a) SUBROUTINE IVALUE(XI,PI,XKTPRE,T,XT,V)

Purpose: At a given time T, to compute I(I) for I = 1,...,12

Input:

T = year for which quantities are being computed, with

T = 0 denoting 1954

T = 1 denoting 1955, etc.

XT = real T

for I = 1,...,12

PI(I)= capital share of value-added or profit by industry I ($million)

K(I) = capital stock of industry I ($million) at time T-1

V(I) = value-added by industry I ($million)

Output:

I(I) = investment of industry I ($million)

Procedure: Compute all values of I(I) for I = 1,...,12.

(b) SUBROUTINE NODEM(XI,E,XM,G,V,XN,UN,YSTAR,XC,YREG,XNBAR,XNTOT,
XL,U,XLU,QC,QBAR)

Purpose: To compute the values of the variables listed under output.

Input:

For I = 1,...,12

I(I) = investment of industry I ($million)

E(I) = export by industry I ($million)

M(I) = import by industry I ($million)

G = local government expenditure ($million)

V(I) = value-added by industry I ($million)

N(I) = employment by industry I (1000)

UN = national unemployment rate (percentage)

Output:

Y* = regional expenditure ($million)

C = consumption ($million)

Y = regional income ($million)

N-BAR = employment by industries other than manufacturing

N = total employment (1000)

L = total labor force (1000)

U = unemployment (1000)

SMALL U = local employment rate (percent)

QC = electric-power demand for residential use (1000 kilowatt hours)

Q-BAR = electric-power demand for non-manufacturing industries (1000 kilowatt hours)

Procedure: Compute the output variables as specified by the equations in Section 7.4.2.

(c) FUNCTION SUM (ABC)

Purpose: To sum the elements in a one-dimensional array of length 12.

Input:

ABC = The array that is to be summed

Output:

SUM = The sum of the elements in the array

Procedure:

(1) Set the variable C = 0.0

(2) Sum the elements of the array by means of a loop over J:

$$C = C + ABC(J),$$

with J ranging between 1 and 12.

(3) Set SUM = C.

7.7.3 Program Inputs

Card 1: Problem Identification Alphanumeric (Format 20A4)

Card 2:

Col. 1 - 3	INIT	(initial value of T)
Col. 4 - 6	LAST	(maximum value of T)
Col. 7 - 9	INCRT	(increment of T at each iteration)

Cards 3 & 4: Values of K(I), I = 1,...,12, for time T-1; denoted by XKTPRE (I)

Card 3:

Col. 1 - 10 XKTPRE (1)

Col. 11 - 20 XKTPRE (2)

. .

. .

. .

Col. 71 - 80 XKTPRE (8)

Card 4:

Col. 1 - 10 XKTPRE (9)

. .

. .

. .

Col. 31 - 40 XKTPRE (12)

Cards 5 & 6: Values of YN(I), I = 1,...,12, for time T

Card 5: Col. 1 - 8 YN(1)
Col. 9 - 16 YN(2)
. .
. .
. .
Col. 65 - 72 YN(10)

Card 6: Col. 1 - 8 YN(11)
Col. 9 - 16 YN(12)

Card 7: Col. 1 - 10 CAPT (at time T)
Col. 11 - 20 UN (at time T)

Cards 8 & 9: Values of COC(I), I = 1,...,12, for time T

Card 8: Col. 1 - 10 COC(1)
Col. 11 - 20 COC(2)
. .
. .
. .
Col. 71 - 80 COC(8)

Card 9: Col. 1 - 10 COC(9)
. .
. .
. .
Col. 31 - 40 COC(12)

For each new T, seven new input cards are required. These will have the same format as cards (3) through (9) and will immediately follow them; i.e., with each change in T, seven input cards are added to the back of the data deck.

7.7.4 Program Outputs

Page 1. A one-line alphanumeric title is printed.

Pages 2-5. The constants used to compute output variables are listed.

For I = 1,...,12

(a) A1(I) and B1(I), as given in Equation (1) Section 7.5, are used to compute E(I).

(b) A2(I), as given in Equation (2), is used to compute V(I).

(c) A3(I), as given in Equation (3), is used to calculate M(I).

(d) 1-BETA(I), as given in Equation (5), is used to compute PI(I).

(e) BETA(I), also given in Equation (5), is used to calculate N(I).

(f) D7(I), given in Equation (7), is used to calculate K(I).

(g) A17(I) and C17(I), given in Equation (17), are used to calculate Q(I) for I $\neq$ 2.

(h) W20(I) and A20(I), given in Equation (20), are used to compute W(I).

The input values that depend upon T are printed out.

For I = 1,...,12

(a) K(I) at time T-1, denoted KTPRE(I), is given, followed by

(b) YN(I) at time T,

(c) CAPITAL T and UN at time T, and

(d) COC(I) at time T.

For the given time T, values for the output parameters, computed without a cost control factor, are listed in the following order:

(a) For I = 1,...,12; E(I), V(I), M(I), PI(I), I(I), K(I), N(I), and Q(I).

(b) G, Y*, C, Y, N-BAR, N, L, U, SMALL U, QC, and Q-BAR.

(c) For I = 1,...,12; W(I).

For time T, the output variables listed above, which are affected by and have been recalculated using cost control, are printed out in the following order:

(a) For I = 1,...,12; PI*(I), I*(I), K*(I), V*(I), N*(I), M*(I), and Q*(I).

(b) (Y*)*, C*, (Y)*, N-BAR*, N*, L*, U*, SMALL U*, QC*, and Q-BAR.

The extra asterisk in the name of an output variable indicates that this parameter was evaluated using a cost control factor.

7.7.5 Sample Computer Output

Tables 7-1 through 7-4 illustrate the inputs and outputs printed by the computer for a sample run of the Regional Econometric Model.

TABLE 7-1 ECONOMETRIC INPUT VALUES

```
TO CALCULATE I(I) AT TIME T =  4 (1958), WE NEED AS AN INPUT VALUE K(I) AT TIME T-1 =  3 (1957).
  THESE VALUES, DENOTED BY THE NAME KTPRE, ARE

      KTPRE( 1) =     253.439987          KTPRE( 2) =      81.789993          KTPRE( 3) =      54.029999
      KTPRE( 4) =     298.629883          KTPRE( 5) =     230.309998          KTPRE( 6) =     120.109985
      KTPRE( 7) =     255.729996          KTPRE( 8) =     101.269989          KTPRE( 9) =      87.139999
      KTPRE(10) =      57.500000          KTPRE(11) =     193.099991          KTPRE(12) =     227.639999


 ADDITIONAL REQUIRED INPUT, GIVEN AT TIME T =  4 (1958) IS:

      YN( 1) =  11098.000000          YN( 2) =    4061.000000          YN( 3) =    5727.000000
      YN( 4) =   7820.000000          YN( 5) =    4071.000000          YN( 6) =    4075.000000
      YN( 7) =   9514.000000          YN( 8) =    9209.000000          YN( 9) =    9877.000000
      YN(10) =   8411.000000          YN(11) =    8201.000000          YN(12) =   25677.000000

      CAPITAL T =     231.299988          UN =       6.799999

  THE COST OF CONTROL FOR EACH INDUSTRY (I) IS:

      COC( 1) =      19.672989          COC( 2) =       2.615000          COC( 3) =       4.292000
      COC( 4) =      19.385986          COC( 5) =       6.080000          COC( 6) =       6.139000
      COC( 7) =       7.782000          COC( 8) =       7.936999          COC( 9) =       6.526999
      COC(10) =       5.490999          COC(11) =      24.114990          COC(12) =       4.500000
```

TABLE 7-2 INDUSTRY OUTPUT VALUES (WITHOUT CONTROL COSTS)

```
FOR T =  4 (1958) WE HAVE THE FOLLOWING

  (A) VALUES COMPUTED WITHOUT THE CCST CONTROL FACTOR
      EXPORT                    VALUE ADDED                 INVESTMENT                    CAPITAL STOCK

                                                           I( 1) =      18.493393       K( 1) =     254.762360
      E( 1) =    559.768066     V( 1) =     357.691650
                                                           I( 2) =       4.228829       K( 2) =      81.658325
      E( 2) =     54.612411     V( 2) =      62.421967
                                                           I( 3) =       3.194233       K( 3) =      53.550659
      E( 3) =     98.048355     V( 3) =     112.069229
                                                           I( 4) =      19.781052       K( 4) =     298.445068
      E( 4) =    514.785645     V( 4) =     284.676270
                                                           I( 5) =      14.348923       K( 5) =     230.505966
      E( 5) =    160.732910     V( 5) =      88.885284
                                                           I( 6) =       6.467133       K( 6) =     119.896408
      E( 6) =     83.054474     V( 6) =     109.631866
                                                           I( 7) =      16.141541       K( 7) =     257.453857
      E( 7) =    269.319824     V( 7) =     185.292083
                                                           I( 8) =       9.067748       K( 8) =     103.119385
      E( 8) =    198.211456     V( 8) =     192.661514
                                                           I( 9) =      13.521965       K( 9) =      93.883575
      E( 9) =    197.561478     V( 9) =     154.295502
                                                           I(10) =       4.241197       K(10) =      57.497894
      E(10) =    187.332275     V(10) =     132.631226
                                                           I(11) =      14.665298       K(11) =     192.660751
      E(11) =    597.377930     V(11) =     483.278564
                                                           I(12) =       5.505866       K(12) =     216.859695
      E(12) =    311.992432     V(12) =     296.080566

      IMPORT                    CAPITAL SHARE OF VALUE ADDED  EMPLOYMENT                  ELECT. POWER DEMAND
                                                           N( 1) =      30.389481       C( 1) =     206.923889
      M( 1) =    236.434158     PI( 1) =    196.730377
                                                           N( 2) =       7.891273       C( 2) =      79.035233
      M( 2) =     17.790253     PI( 2) =     26.154800
                                                           N( 3) =      12.736234       C( 3) =      34.172714
      M( 3) =     31.939713     PI( 3) =     42.922501
                                                           N( 4) =      16.585445       C( 4) =     328.454590
      M( 4) =    258.201172     PI( 4) =    193.864532
                                                           N( 5) =       4.618154       C( 5) =     228.680099
      M( 5) =     80.618942     PI( 5) =     60.797516
                                                           N( 6) =       9.916475       C( 6) =     305.697998
      M( 6) =     36.068878     PI( 6) =     61.393829
                                                           N( 7) =      19.864092       C( 7) =     190.260406
      M( 7) =    112.101654     PI( 7) =     77.822632
                                                           N( 8) =      22.732712       C( 8) =      99.396042
      M( 8) =     75.330643     PI( 8) =     79.376526
                                                           N( 9) =      17.131149       C( 9) =      41.161606
      M( 9) =     52.769043     PI( 9) =     65.266983
                                                           N(10) =      15.858154       C(10) =     116.070023
      M(10) =     72.681900     PI(10) =     54.909317
                                                           N(11) =      42.419464       C(11) =     261.302734
      M(11) =    157.257119     PI(11) =    241.155975
                                                           N(12) =      61.454239       C(12) =     357.183350
      M(12) =    148.336349     PI(12) =     45.004227
```

TABLE 7-3 INDUSTRY OUTPUT VALUES (WITH CONTROL COSTS)

```
(B) NEW VALUES COMPUTED WITH COST CONTROL FACTOR
   CAPITAL SHARE OF VALUE ADDED    INVESTMENT                    EMPLOYMENT                     IMPORT

   PI*( 1) =    177.C57388     I*( 1) =        13.358734     N*( 1) =        29.815643     M*( 1) =       231.969666
   PI*( 2) =     23.539795     I*( 2) =         4.059377     N*( 2) =         7.875730     M*( 2) =        17.755203
   PI*( 3) =     38.630493     I*( 3) =         2.772329     N*( 3) =        12.642334     M*( 3) =        31.704224
   PI*( 4) =    174.478546     I*( 4) =        17.648590     N*( 4) =        16.474350     M*( 4) =       256.471680
   PI*( 5) =     54.717514     I*( 5) =        12.579651     N*( 5) =         4.584756     M*( 5) =        80.035934
   PI*( 6) =     55.254822     I*( 6) =         6.168777     N*( 6) =         9.893103     M*( 6) =        35.983856
   PI*( 7) =     7C.040619     I*( 7) =        13.441177     N*( 7) =        19.607407     M*( 7) =       110.988327
   PI*( 8) =     71.439514     I*( 8) =         7.766078     N*( 8) =        22.464523     M*( 8) =        74.441956
   PI*( 9) =     58.739975     I*( 9) =        12.980873     N*( 9) =        17.C39063     M*( 9) =        52.485397
   PI*(10) =     49.418304     I*(10) =         3.829370     N*(1C) =        15.792105     M*(10) =        72.197883
   PI*(11) =    217.C40985     I*(11) =        10.662201     N*(11) =        41.6C2127     M*(11) =       742.705566
   PI*(12) =     4C.5C4227     I*(12) =         5.220117     N*(12) =        61.378891     M*(12) =       148.154465
   CAPITAL STOCK                   VALUE ADDED                   ELECT. POWER DEMAND            EXPORT

   K*( 1) =     249.951828     V*( 1) =       350.937500     Q*( 1) =       202.891663     E*( 1) =       549.198242
   K*( 2) =      81.497467     V*( 2) =        62.298996     Q*( 2) =        78.558611     E*( 2) =        54.504822
   K*( 3) =      53.155838     V*( 3) =       111.242950     Q*( 3) =        33.836990     E*( 3) =        97.325455
   K*( 4) =     296.446045     V*( 4) =       282.769287     Q*( 4) =       327.834473     E*( 4) =       511.337402
   K*( 5) =     228.839050     V*( 5) =        88.242493     Q*( 5) =       228.508347     E*( 5) =       159.570541
   K*( 6) =     118.616150     V*( 6) =       109.373444     Q*( 6) =       305.425781     E*( 6) =        82.058688
   K*( 7) =     254.896973     V*( 7) =       183.451797     Q*( 7) =       187.824310     E*( 7) =       266.645020
   K*( 8) =     101.5C2078     V*( 8) =       190.388657     Q*( 8) =        97.537750     E*( 8) =       195.073123
   K*( 9) =      93.378922     V*( 9) =       153.466110     Q*( 9) =        41.072861     E*( 9) =       196.499512
   K*(10) =      57.114365     V*(10) =       131.746521     Q*(1C) =       115.39C472     E*(10) =       186.002607
   K*(11) =     188.548669     V*(11) =       473.966797     Q*(11) =       257.358154     E*(11) =       585.867920
   K*(12) =     216.5939C3     V*(12) =       295.717529     Q*(12) =       356.392578     E*(12) =       311.609863
```

TABLE 7-4 REGIONAL OUTPUT VALUES (WITH CONTROL COSTS)

```
G =       247.463274                  Y* =     4945.812500                  C =     3215.444580

Y =     4072.985595                   N-BAR =     517.255371                N =      778.832031

L =       835.354248                  U =       56.522217                   SMALL U =       6.766253

QC =     1501.230713                  Q-BAR =    1214.385986

W( 1) =         5.296610              W( 2) =         4.595855              W( 3) =         5.429131
W( 4) =         5.475380              W( 5) =         6.082027              W( 6) =         4.864430
W( 7) =         5.426623              W( 8) =         4.983345              W( 9) =         5.196874
W(10) =         4.888737              W(11) =         5.707816              W(12) =         4.085581
```

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APPENDIX A PROGRAM CODING

APPENDIX A
FORTRAN IV PROGRAM CODE

A.1 ATMOSPHERIC DIFFUSION MODEL

A.2 CONTROL COST-EFFECTIVENESS MODEL

A.3 ABATEMENT STRATEGY MODEL

A.4 REGIONAL ECONOMETRIC MODEL

A.1 ATMOSPHERIC DIFFUSION MODEL

```
      SUBROUTINE ZVALU2(P,Z)
C
C     P=PERCENT VALUE EXPRESSED IN DECIMAL
C
C     Z=REDUCED NORMAL VARIATE
C
      A0=2.515517
      A1=0.302853
      A2=0.010328
      B1=1.432738
      B2=0.189269
      B3=0.001308
      U=SQRT(ALOG(1./(P*P)))
      Z=U-(A0+A1*U+A2*U*U)/(1.+B1*U+B2*U*U+B3*U*U*U)
      RETURN
      END
/*
```

```
      SUBROUTINE ORDER(N,A,NRECEP)
C
C     THIS ROUTINE SORTS UP TO 225 NUMBERS IN ASCENDING ORDER.
C
      DIMENSION A(N), NRECEP(N)
C
      M=N-1
      DO 100 I=1,M
      K=I+1
      DO 100 J=K,N
      IF (A(I)-A(J)) 10,100,100
C
C     ORDER THE CONCENTRATION VALUES
   10 TEMP=A(I)
      A(I)=A(J)
      A(J)=TEMP
C     ORDER THE RECEPTOR NUMBERS
      TEMP=NRECEP(I)
      NRECEP(I)=NRECEP(J)
      NRECEP(J)=TEMP
  100 CONTINUE
      RETURN
      END
      SUBROUTINE ZVALL1(P,Z)
C
C     P=PERCENT VALUE EXPRESSED IN DECIMAL
C
C     Z=REDUCED NORMAL VARIATE
C
      A0=2.515517
      A1=0.802853
      A2=0.010328
      B1=1.432788
      B2=0.189269
      B3=0.001308
      U=SQRT(ALOG(1./(P*P)))
      Z=U-(A0+A1*U+A2*U*U)/(1.+B1*U+B2*U*U+B3*U*U*U)
      RETURN
      END
      NDF=NRECEP-2
      IF (R-CORREL(NDF)) 922,922,921
  921 AC(IPOLUT,ISEASN)=AAA
      BC(IPOLUT,ISEASN)=BBB
      WRITE (6,1421)AAA,BBB,R,CORREL(NDF),NDF
 1421 FORMAT (20X,'Y-INTERCEPT=',F12.5,'SLOPE=',F12.5,'R=',F12.5,
     1          'CORRELATION COEFFICIENT=',F12.5,'DEG. OF FREEDOM=',I5)
      GO TO 980
  922 WRITE (6,1422)  R
 1422 FORMAT (30X,'POOR CORRELATION',10X,'R=',F12.5)
  980 CONTINUE
      RETURN
      END
      SUBROUTINE REG
C              THIS SUBROUTINE COMPUTES THE Y-INTERCEPT, SLOPE,AND
C              CORRELATION COEFFICINT OF REGRESSION EQ. BETWEEN
C              OBSERVED CONCENTRATION AND CALCULATED CONCENTRATION.
C              AC........Y-INTERCEPT
C              BC........SLOPE
C
      COMMON /DOL/ IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),OPOLUT(3,3,20),
     1        PTCON(3,3,237),NRECEP ,IRECEP,XRECEP(2,12),IADD
     2         ,JRECEP(3,3,237)
      COMMON /RGSN/ AC(3,3),BC(3,3),CORREL(25)
C
  910 DO 980 ISEASN=ITIME1,ITIME2,ISKIPT
      DO 980 IPOLUT=IPOLU1,IPOLU2,ISKIPP
      SX=0.
      SY=0.
      SX2=0.
      SY2=0.
      SXY=0.
      DO 920 IRECEP=1,NRECEP
      OP=OPOLUT(IPOLUT,ISEASN,IRECEP)
      CP=CPOLUT(IPOLUT,ISEASN,IRECEP)
      SX=SX+CP
      SY=SY+OP
      SX2=SX2+CP*CP
      SY2=SY2+OP*OP
  920 SXY=SXY+OP*CP
      AN=FLOAT(NRECEP)
      TSX=SX2-SX*SX/AN
      TSY=SY2-SY*SY/AN
      TXY=SXY-(SX*SY)/AN
      XM=SX/AN
      YM=SY/AN
      BBB=TXY/TSX
      AAA=YM-BBB*XM
      R=TXY/SQRT(TSX*TSY)
      IF (IPOLUT.EQ.1) SC=SC*ALIFE
  402 CPOLUT(IPOLUT,ISEASN,IRECEP)=CPCLUT(IPOLUT,ISEASN,IRECEP)+SC
  500 CONTINUE
C     END CF LOOP ON PCLLLTANTS
C                                                                      DIFMOD2
  600 CONTINUE                                                         DIFMOD2
C                                                                      DIFMOD2
C     END OF LOOP ON SEASCN                                     ISEASN DIFMOD2
C                                                                      DIFMOD2
  700 CONTINUE                                                         DIFMOD2
C                                                                      DIFMOD2
C     END OF LOOP ON WIND DIRECTION                             IWNDIR DIFMOD2
C                                                                      DIFMOD2
  800 CONTINUE                                                         DIFMOD2
C                                                                      DIFMOD2
C     END OF LOOP ON SCURCE                                     ISORCE DIFMOD2
C                                                                      DIFMOD2
      WRITE (6,8800) IRECEP,RECEPT(1,IRECEP),RECEPT(2,IRECEP),
     1 ((OPOLUT(IPOLUT,ISEASN,IRECEP),IPCLUT=IPOLU1,IPOLU2,ISKIPP),
     2                       ISEASN=ITIME1,ITIME2,ISKIPT)
      WRITE (6,8800) IRECEP,RECEPT(1,IRECEP),RECEPT(2,IRECEP),
     1 ((CPOLUT(IPOLUT,ISEASN,IRECEP),IPOLUT=IPOLU1,IPOLU2,ISKIPP),
     2                       ISEASN=ITIME1,ITIME2,ISKIPT)
8800 FORMAT (I5,2F8.2,5E12.5)
  900 CONTINUE                                                         DIFMOD2
      RETURN
      END
  160 SIGZ=A(L)*DNWIND**B(L)+C(L)                                       DIFMOD2
      Q=Q*(Y-CXWIND)/Y                                                  DIFMOD2
C     LOOP ON SEASON                                             ISEASN DIFMOD2
C                                                                       DIFMOD2
      DO  600 ISEASN=ITIME1,ITIME2,ISKIPT                               DIFMOD2
      U=UM(IWNDIR,ISEASN)
      IF (TS(ISORCE)) 180,180,170
  170 PHT=HS(ISORCE)+VS(ISORCE)*DS(ISORCE)*(1.5+.00268*PA*DS(ISORCE)*
     1    (TS(ISORCE)-TA)/TS(ISORCE))/U
  180 ALIFE=EXP(-.693*(DNWIND/U)/10800.)
      DMIX=DPTHMX(ISEASN)                                               DIFMOD2
C     NOTE -- Y IS SET TO THE PRODUCT OF Q, ARG2,  AND FOVU OF VER 1    DIFMOD2*
      Y=Q*WDFREQ(IWNDIR,ISEASN)                                         DIFMOD2*
      SGTDMX=.TRUE.                                                     DIFMOD2
      IF(SIGZ .LE. (0.47*DMIX)) GO TO 310                               DIFMOD2
      X1=EXP(ALOG((0.47*DMIX-C(1))/A(1))/B(1))                          DIFMOD2*
      IF(X1 .LT. 1000.) X1=EXP(ALOG((0.47*DMIX-C(2))/A(2))/B(2))        DIFMOD2*
      IF(X-2.*X1)220,210,210                                            DIFMOD2
  210 XD=X                                                              DIFMOD2
      GO TO 230                                                         DIFMOD2
  220 XD=2.0*X1                                                         DIFMOD2
      SGTDMX=.FALSE.                                                    DIFMOD2
  230 C2=(0.0255*Y)/(DMIX*XD)                                           DIFMOD2*
      IF(.NOT. SGTDMX) GO TO 240                                        DIFMOD2
      C3=C2                                                             DIFMOD2
      GO TO 5000
  240 XD=X1                                                             DIFMOD2
      GO TO 320                                                         DIFMOD2
  310 XD=X                                                              DIFMOD2
  320 C1=(.0203*Y)/(SIGZ*XD)*(EXP((-.5*PHT*PHT)/(SIGZ*SIGZ)))
      IF(.NOT. SGTDMX) GO TO 330                                        DIFMOD2
      C3=C1                                                             DIFMOD2
      GO TO 5000
  330 C3=C1-((X-X1)/X1)*(C1-C2)                                         DIFMOD2
C
 5000 DO 500 IPOLUT=IPOLL1,IPOLL2,ISKIPP
      SC=C3*SINTEN(IPOLLT,ISEASN,ISORCE)
```

```
C
      SRAD=SDIAM/2.                                                    DIFMOD2
C     LOOP ON WIND DIRECTICN                                    IWNDIR DIFMOD2
      DO  700 IWNDIR=1,16                                              DIFMOD2
C                                                                      DIFMOD2
      L=1                                                              DIFMOD2
      DNWIND=GDSCAL*((SOURCE(2,ISORCE)-RECEPT(2,IRECEP))*COSWD(IWNDIR)+ DIFMOD2
     1             (SOURCE(1,ISORCE)-RECEPT(1,IRECEP))*SINWD(IWNDIR)) DIFMOD2
      X=DNWIND+SDIAM/PI8                                               DIFMOD2
      IF(SDIAM .GT. 1CC.) GC TC 110                                    CIFMOD2
      IF(X) 700, 700,1C0
  100 PHT=HS(ISORCE)
      GO TO 120
  110 IF(SRAD+DNWIND)7CC,700,115
  115 PHT=0.0
  120 CXWIND=GDSCAL*ABS((SCURCE(2,ISORCE)-RECEPT(2,IRECEP))*            DIFMOD2
     1SINWD(IWNDIR)-(SOURCE(1,ISORCE)-RECEPT(1,IRECEP))*COSWD(IWNDIR)) DIFMOD2
      Y=X*PI8                                                          DIFMOD2
      IF(Y .LE. CXWINC) GC TC 700                                      DIFMOD2
      IF( SRAD     .GT. ABS(DNWIND)) GO TO 130                         DIFMOD2
      IF(SDIAM  .LE. (DNWINC*PI8)) GO TO 140                           DIFMOD2
      Q=QSCALE*((PI8*X-SDIAM)/SCIAM)                                   DIFMOD2
      DNWIND=SQRT((DNWIND*DNWINC)+(SRAD*SRAD))                         DIFMOD2
C     FROM DNWIND=((4.*CNWIND**2.+SDIAM**2.)**.5)/2.   (DISTANCE TERM ?)DIFMOD2
      X=2.*DNWIND                                                      DIFMOD2
      IF(CXWIND-(SRAD+X*PI8))150,150,700                               DIFMOD2
  130 Q=QSCALE*(PI4*(X*X-4.C8*X*SDIAM+4.1616*SDIAM*SCIAM))/(SRAD*SRAD* DIFMOD2
     1                                                         16.)    DIFMOD2
C     FROM Q=QSCALE*(.1965*(X-2.040*SCIAM)**2.)/SDIAM**2.              DIFMOD2
      DNWIND=SINWD(3)*(DNWIND+SRAD)                                    DIFMOD2
C     WHERE SINWD(3) = SIN(PI8*2) OR SIN(PI/4) OR .70711              DIFMOD2
      X=DNWIND*2.                                                      DIFMOD2
      IF(CXWIND-SRAD)150,15C,7C0                                       DIFMOD2
  140 Q=QSCALE                                                         DIFMOD2
  150 IF(DNWIND .GE. 1CCC.) GC TC 160                                  DIFMOD2
      IF(DNWIND .LT. 1CC.) DNWIND=100.                                 DIFMOD2
      L=2                                                              DIFMOD2
      SUBROUTINE POLUT1
C     *******************SPECIFICATION STATEMENTS**********************DIFMOD2
      LOGICAL SGTDMX                                                    DIFMOD2
C               FCR SIGZ GREATER THAN DMIX -- A LCGICAL VARIABLE        DIFMOD2
      LOGICAL PNCH/.TRUE./                                              DIFMOD2
C               FCR PLNCH - OR NOT PUNCH 1130 DECK                      DIFMOD2
      LOGICAL REPLAY/.FALSE./                                           DIFMOD2
C             ALLOW WRITING TO CONVERTED DATA                           DIFMOD2
C
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              ACSTAN(2,3,3)
      COMMON /CONS/ PI4,PI8,NCCLPG,NLEFT,NRIGHT
      COMMON /CORD/ CCNVER(2),ORIGIN(2),RBASE(2),DELTA,SMTOSK,FTTOKM,
     1              GCSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,QSCALE
      COMMON /DOL/ IPCLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /LITL/ AEBREV(6),REGION(18),APOIN(4,2),PNAME(6,3),
     1              PLNITS(5,3),SNAME(2,3)
      COMMON /LOGI/ SGTDMX,PNCH,REPLAY
      COMMON /MAX/  MXRECP,MXPCL,MXSESN,MXINTV
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),OPCLUT(3,3,20),
     1             PTCCN(3,3,237),NRECEP ,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
      COMMON /RGSN/ AC(3,3),BC(3,3)
      COMMON /SRCE/ SCURCE(3,200),SINTEN(3,3,237),NSCRCE,CS(3,3,200)
     1       ,IFLAG
      COMMON /STAK/ HS(2CC),VS(2CO),DS(200),TS(200),PA,TA
      COMMON /WIND/ WCFREC(16,3),SINWD(16),COSWD(16),DPTHMX(3),UW(16,3)
C                                                                       DIFMOD2
C     LOOP ON SOURCE                                             ISORCE CIFMOD2
      DO  800 ISORCE=1,NSORCE                                           DIFMOD2
      SDIAM=SOURCE(3,ISORCE)                                            DIFMOD2
C
C     SET UP FLAG FO PCINT SCLR
      IPOINT=0
      IF (SDIAM.LE.100) IPCINT=1
      SUBROUTINE CAMP
      COMMON /DOL/ IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /RGSN/ AC(3,3),BC(3,3)
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),OPOLUT(3,3,20),
     1             PTCON(3,3,237),NRECEP ,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      DO 10 IRECEP=1,NRECEP
      CALL POLUT1
   10 CONTINUE
C
      CALL REG
      RETURN
      END
      SUBROUTINE PLOT
      COMMON /DOL/ IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),OPOLUT(3,3,20),
     1              PTCON(3,3,237),NRECEP ,IRECEP,XRECEP(2,12),IADD
     2               ,JRECEP(3,3,225)
C                                                                       DIFMOD2
C     ******************PUNCH 1130 INPUT********************************DIFMOD2
C
C     LOOP ON RECEPTOR                                           IRECEP DIFMOD2
      DO   2050 IRECEP=1,NRECEP                                         DIFMOD2
C     PUNCH A RECEPTOR DATA CARD                                        DIFMOD2
      WRITE (7,72050) (RECEPT(L,IRECEP),L=1,2),((CPOLUT(IPOLUT,
     1         ISEASN,IRECEP),IPOLUT=IPOLU1,IPOLU2,ISKIPP),
     2         ISEASN=ITIME1,ITIME2,ISKIPT)
72050 FORMAT (2P2F8.0,1X,3(5PF7.0,3PF5.0,8PF9.0))
 2050 CONTINUE                                                          DIFMOD2
      WRITE (7,72055)                                                   DIFMOD2
72055 FORMAT ('¬¬')                                                     DIFMOD2
C                                                                       DIFMOD2
C     THE REMAINING CARDS FOR THE 1130 MUST BE PUNCHED BY HAND.
C     IF THE RANGE OF Z WERE TOO
C     GREAT, THE NUMBER OF CONTROL CARDS MAY BE INCREASED BY AN EVEN NUMBER.
C     FOR EXAMPLE IF THE RANGE WERE FROM 0 TO 5000, THE ENTIRE GRAPH MAY BE
C     PLOTTED AS A COMBINATION OF TWO SUPERIMPOSED GRAPHS, THE OUTER GRAPH
C     HAVING THE Z-VALUES FROM 0 TO 100, THE INNER GRAPH HAVING THE Z-VALUES
C     FROM 100 TO 5000, THUS FOUR CONTROL CARDS ARE NEEDED TO ACCOMPLISH THIS.
C     IF ANNOTATION IS NEEDED USE XEQ MAPAT.
C****************************1130 DATA HAS BEEN PUNCHED*****************DIFMOD2
      RETURN
      END
      CPER(M) = GEOM * SIGK**ZFREQ                                      SEL12003
   60 CONTINUE                                                          SEL12003
C                WRITE C/P CATA LINE                                    SEL12003
      WRITE (6,992) IRECEP,XP(I,J,L),GEOM,CMAX,(CPER(M),M=1,3)          SEL12003
C                                                                       SEL12003
  200 CONTINUE                                                          SEL12003
  300 CONTINUE                                                          SEL12003
C                                                                       SEL12004
      RETURN                                                            SEL12004
C                                                                       SEL12004
  990 FORMAT('1',T39,'STATISTICAL DATA FOR SELECTED RECEPTORS',///,T3,  SEL12004
     1'POLLUTANT  ',I2,/,T3,'SEASON  ',I2,////)                         SEL12004
C                                                                       SEL12004
  991 FORMAT(' ',T3,'AVERAGING TIME ',F4.0,' HRS. HAS STANDARD DEVIATION
     1 = ',F5.2//T3,28('____'),'___',/,T3,'RECEPTOR  |  ARITHMETIC  |  G
     2EOMETRIC   |     MAXIMUM     |      ',3(F5.1,'%      |       '),/,
     3 T13,'|',T19,'MEAN      |      MEAN      |  CONCENTRATION  |',
     4 3('   CONCENTRATICN  |'),/,T3,29('----')/)
C                                                                       SEL12004
  992 FORMAT(' ',T5,I3,T14,1PE13.6,T3C,1PE13.6,T46,1PE13.6,T64,1PE13.6,
     1 T82,1PE13.6,T1CC,1PE13.6,/)
C                                                                       SEL12004
      END                                                               SEL12004
     1      / ALOG(TTIME      / 24.)                                  SEL12002
C                                    WRITE HEADER LINE.               SEL12001
      WRITE (6,990) I,J                                               SEL12001
C                                                                     SEL12002
C    WRITE AVE. TIME, STAND DEV. AND COLUMN HEADINGS                  SEL12002
      WRITE (6,991) AVRGTM(K),SIGK, (PERCNT(N),N=1,3)                 SEL12002
C                                                                     SEL12002
C                              SET 12 RECEPTOR LOOP.                  SEL12002
      DO 200 L = 1,12                                                 SEL12002
C                         GET RECEPTOR NUMBER FOR  POLUT              SEL12002
      IRECEP = ISEL12(I,J,L)                                          SEL12002
C                                                                     SEL12002
C   COMPUTE GEOM. MEAN  USING ARITH. MEAN (XP)                        SEL12002
      GEOM = XP(I,J,L) / STANDV(I,J)**(.5*ALOG(STANDV(I,J)))          SEL12002
C                                                                     SEL12002
C   COMPUTE  GEOM. MEAN AT AVE. TIME K                                SEL12002
      GEOM = GEOM * STANDV(I,J)** EXP                                 SEL12002
C                                                                     SEL12002
C   COMPUTE MAXIMUM CONCENTRACTION FOR AVE. TIME K.                   SEL12002
C                                                                     SEL12003
      FREQ = 0.6 / (TTIME      / AVRGTM(K))                           SEL12003
C                                                                     SEL12003
      CALL ZVALU2(FREQ,ZFREQ)
C                                                                     SEL12003
      CMAX = GEOM * SIGK**ZFREQ                                       SEL12003
C                                                                     SEL12003
C   COMPUTE PERCENTILE CONCENTRATION FOR 3 PERCENTILES.               SEL12003
C                                                                     SEL12003
      DO 60 M = 1,3                                                   SEL12003
C                                                                     SEL12003
      FREQ = PERCNT(M)/100.                                           SEL12003
C                   TEST FOR AN M PERCENTILE,SET C/P TO 0 IF M % = 0.SEL12003
      IF (FREQ .GT. 0.) GO TO 50                                      SEL12003
      CPER(M) = 0.                                                    SEL12003
      GO TO 60                                                        SEL12003
C                                                                     SEL12003
   50 CALL ZVALU2(FREQ,ZFREQ)
```

```
      SUBROUTINE  SEL12                                                 SEL12001
C                                                                       SEL12001
      DIMENSION CPER(3)                                                 SEL12001
      COMMON /SELCT/ISEL12(3,3,12),NSEL12,ISEL(3,3,5),NSEL5,XP(3,3,12)  SEL12001
      COMMON /DOL/IPOLU1,IPCLU2,ITIME1,ITIME2,ISKIPP,ISKIPT             SEL12001
      COMMON /AIRQ/DUM(18),STANCV(3,3),DUM1(81),AVRGTM(5),AQSTAN(2,3,3) SEL12001
     1                       ,PERCNT(3)                                 SEL12001
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),OPCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
C                                                                       SEL12001
C  SEL12 WILL COMPUTE,THE GECMETRIC MEAN (GEOM), THE MAXIMUM            SEL12001
C     CONCENTRATION (CMAX), THE % CONCENTRATION FOR 3 PERCENTILES       SEL12001
C     (CPER) FOR 5 AVERAGING TIMES FCR THE 12 SELECTED RECEPTORS.       SEL12001
C                       SET AVE. TIME LOOP                              SEL12002
      DO  10 K = 1,5                                                    SEL12001
C                     TEST FOR  NUMBER OF AVE.TIMES                     SEL12001
      IF (AVRGTM(K) .LE. C.) GC TO 15                                   SEL12001
      NAVE = K                                                          SEL12001
   10 CONTINUE                                                          SEL12001
C                                         START POLLUTANT LCOP.         SEL12001
   15 DO 300 I = IPOLL1,IPOLU2,ISKIPP                                   SEL12001
C                                          START SEASON LCCP.           SEL12001
   20 DO 300 J = ITIME1,ITIME2,ISKIPT                                   SEL12001
      IF (ISEL12(I,J,1) .EQ. 0) GO TO 300                               SEL12001
C                                                                       SEL12001
C   COMPUTE TOTAL TIME                                                  SEL12001
C                                                                       SEL12001
      TTIME = 2190.
      IF (J .EQ. 3) TTIME = 876C.                                       SEL12001
C                        START AVE. TIME LOOP.                          SEL12001
   30 DO 200 K = 1,NAVE                                                 SEL12002
C                        COMPLTE STAND DEV. FOR AVE. TIME K.            SEL12002
      SIGK = STANDV(I,J)**(SQRT(ALOG(TTIME      /AVRGTM(K))             SEL12002
     1       / ALOG(TTIME       / 24.)))                                SEL12002
C  COMPUTE EXPONENT FCR CCNVERTING GECM. MEAN TO AVE. TIME K.           SEL12002
      EXP = (ALOG(AVRGTM(K)/24.) * (.5 * ALOG(STANDV(I,J))))            SEL12002
```

```
  800 CONTINUE                                                          DIFMOD2
C                                                                       DIFMOD2
C                                                                       DIFMOD2
      RETURN
      END
```

```
C     NOTE -- Y IS SET TC THE PRCDUCT OF Q, ARG2,  AND FCVU OF VER 1     DIFMOD2*
      Y=Q*WDFREQ(IWNDIR,ISEASN)                                           DIFMOD2*
      SGTDMX=.TRUE.                                                       DIFMOD2
      IF(SIGZ .LE. (C.47*DMIX)) GO TO 310                                 DIFMOD2
      X1=EXP(ALOG((0.47*DMIX-C(1))/A(1))/B(1))                            DIFMOD2*
      IF(X1 .LT. 10CC.) X1=EXP(ALOG((0.47*DMIX-C(2))/A(2))/B(2))          DIFMOD2*
      IF(X-2.*X1)220,210,210                                              DIFMOD2
  210 XD=X                                                                DIFMOD2
      GO TO 230                                                           DIFMOD2
  220 XD=2.0*X1                                                           DIFMOD2
      SGTDMX=.FALSE.                                                      DIFMOD2
  230 C2=(0.0255*Y)/(DMIX*XD)                                             DIFMOD2*
      IF(.NOT. SGTDMX) GC TC 240                                          DIFMOD2
      C3=C2                                                               DIFMOD2
      GO TO 5000
  240 XD=X1                                                               DIFMOD2
      GO TO 320                                                           DIFMOD2
  310 XD=X                                                                DIFMOD2
  320 C1=0.
      ZEKE=-.5*PHT*PHT/(SIGZ*SIGZ)
      IF (ZEKE.LE.-70.) GC TC 325
      C1= (.0203*Y)/(SIGZ*XD)*(EXP(ZEKE))
  325 IF(.NOT. SGTDMX) GO TO 330                                          DIFMOD2
      C3=C1                                                               DIFMOD2
      GO TO 5000
  330 C3=C1-((X-X1)/X1)*(C1-C2)                                           DIFMOD2
C
 5000 SC=C3*SINTEN(IPCLLT,ISEASN,ISORCE)
      IF (IPOLUT.EQ.1) SC=SC*ALIFE
      CS(IPOLUT,ISEASN,ISCRCE)=CS(IPOLUT,ISEASN,ISORCE)+SC
  402 CONTINUE
  500 CONTINUE
C                                                                         DIFMOD2
  700 CONTINUE                                                            DIFMOD2
C                                                                         DIFMOD2
C     END OF LOOP ON WIND CIRECTION                               IWNDIR DIFMOD2
C                                                                         DIFMOD2
```

```
      IF(SDIAM .GT. 100.) GO TO 110                                     DIFMOD2
      IF(X) 700, 700,100
  100 PHT=HS(ISORCE)
      GO TO 120
  110 IF(SRAD+DNWIND)700,700,115
  115 PHT=0.0
  120 CXWIND=GDSCAL*ABS((SOURCE(2,ISORCE)-RECEPT(2,IRECEP))*            DIFMOD2
     1SINWD(IWNDIR)-(SOURCE(1,ISORCE)-RECEPT(1,IRECEP))*COSWD(IWNDIR))  DIFMOD2
      Y=X*PI8                                                           DIFMOD2
      IF(Y .LE. CXWIND) GO TO 700                                       DIFMOD2
      IF( SRAD     .GT. ABS(DNWIND)) GO TO 130                          DIFMOD2
      IF(SDIAM  .LE. (DNWIND*PI8)) GO TO 140                            DIFMOD2
      Q=QSCALE*((PI8*X-SDIAM)/SDIAM)                                    DIFMOD2
      DNWIND=SQRT((DNWIND*DNWIND)+(SRAD*SRAD))                          DIFMOD2
C     FROM DNWIND=((4.*DNWIND**2.+SDIAM**2.)**.5)/2.   (DISTANCE TERM ?)DIFMOD2
      X=2.*DNWIND                                                       DIFMOD2
      IF(CXWIND-(SRAD+X*PI8))150,150,700                                DIFMOD2
  130 Q=QSCALE*(PI4*(X*X-4.08*X*SDIAM+4.1616*SDIAM*SDIAM))/(SRAD*SRAD*  DIFMOD2
     1                                                             16.) DIFMOD2
C     FROM Q=QSCALE*(.1965*(X-2.040*SDIAM)**2.)/SDIAM**2.               DIFMOD2
      DNWIND=SINWD(3)*(DNWIND+SRAD)                                     DIFMOD2
C     WHERE SINWD(3) = SIN(PI8*2) OR SIN(PI/4) OR .70711                DIFMOD2
      X=DNWIND*2.                                                       DIFMOD2
      IF(CXWIND-SRAD)150,150,700                                        DIFMOD2
  140 Q=QSCALE                                                          DIFMOD2
  150 IF(DNWIND .GE. 1000.) GO TO 160                                   DIFMOD2
      IF(DNWIND .LT. 100.) DNWIND=100.                                  DIFMOD2
      L=2                                                               DIFMOD2
  160 SIGZ=A(L)*DNWIND**B(L)+C(L)                                       DIFMOD2
      Q=Q*(Y-CXWIND)/Y                                                  DIFMOD2
C                                                                       DIFMOD2
      U=UW(IWNDIR,ISEASN)
      IF (TS(ISORCE)) 180,180,170
  170 PHT=HS(ISORCE)+VS(ISORCE)*DS(ISORCE)*(1.5+.00268*PA*DS(ISORCE)*
     1    (TS(ISORCE)-TA)/TS(ISORCE))/U
  180 ALIFE=EXP(-.693*(DNWIND/U)/10800.)
      DMIX=DPTHMX(ISEASN)                                               DIFMOD2
      SUBROUTINE POLUT2(IPOLUT,ISEASN,ISORCE)
C     ******************SPECIFICATION STATEMENTS***********************DIFMOD2
      LOGICAL SGTDMX                                                   DIFMOD2
C                     FOR SIGZ GREATER THAN DMIX -- A LOGICAL VARIABLE DIFMOD2
C
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              ACSTAN(2,3,3)
      COMMON /CONS/ PI4,PI8,NCOLPG,NLEFT,NRIGHT
      COMMON /DOL/ IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /LITL/ ABBREV(6),REGION(18),APOIN(4,2),PNAME(6,3),
     1               PUNITS(5,3),SNAME(2,3),UNTS
      COMMON /CORD/ CONVER(2),ORIGIN(2),RBASE(2),DELTA,SMTOSK,FTTOKM,
     1              GDSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,QSCALE
      COMMON /LOGI/ SGTDMX,PNCH,REPLAY
      COMMON /MAX/  MXRECP,MXPOL,MXSESN,MXINTV
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),OPOLUT(3,3,20),
     1             PTCON(3,3,237),NRECEP ,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
      COMMON /RGSN/ AC(3,3),BC(3,3)
      COMMON /SRCE/ SOURCE(3,200),SINTEN(3,3,237),NSORCE,CS(3,3,200)
     1               ,IFLAG,JSIC(200),JSITE(200)
      COMMON /STAK/ HS(200),VS(200),DS(200),TS(200),PA,TA
      COMMON /WIND/ WDFREQ(16,3),SINWD(16),COSWD(16),DPTHMX(3),UW(16,3)
C                                                                      DIFMOD2
C
      SDIAM=SOURCE(3,ISORCE)                                           DIFMOD2
C
      SRAD=SDIAM/2.                                                    DIFMOD2
C     LOOP ON WIND DIRECTION                                    IWNDIR DIFMOD2
      DO  700 IWNDIR=1,16                                              DIFMOD2
C                                                                      DIFMOD2
      L=1                                                              DIFMOD2
      DNWIND=GDSCAL*((SOURCE(2,ISORCE)-RECEPT(2,IRECEP))*COSWD(IWNDIR)+ DIFMOD2
     1              (SOURCE(1,ISORCE)-RECEPT(1,IRECEP))*SINWD(IWNDIR)) DIFMOD2
      X=DNWIND+SDIAM/PI8                                               DIFMOD2
      RETURN                                                            SELECT03
  990 FORMAT('1',T41,'SOURCE CONTRIBUTIONS TO 5 RECEPTORS',///,T43,
     1 'POLLUTANT  ',I2,T65,'SEASON  ',I2,///)
  991 FORMAT(T20,19('____'),'_')
  992 FORMAT(T20,'| SOURCE',T31,5('|  RECEPTOR  '),'|'/T20,'|',T31,5('|'
     1,3X,I3,6X),'|' ,/'+',T20,19('____'),'_')
C                                                                       SELECT03
  999 FORMAT(' ',T20,'|',T24,I3,T31,5('| '  ,F7.2,' %  '),'|')
C                                                                       SELECT03
      END                                                               SELECT03
      WRITE (6,992) (ISEL5(IPOLLT,ISEASN,I),I=1,KK)
C                                                                       SELECTO2
      DO 7C ISORCE= 1,NSCRCE
      DO 60  I=1,KK
C                          ISEL5 = 5 RECEPTORS I/P CR MAXIMUM           SELECTO2
      IRECEP=ISEL5(IPCLLT,ISEASN,I)
      CS(IPOLUT,ISEASN,ISCRCE)=C.
C                                                                       SELECTO2
      CALL POLUT2(IPOLLT,ISEASN,ISORCE)
  510 CS(IPOLUT,ISEASN,ISCRCE) = AC(IPOLUT,ISEASN) * (CS(IPOLUT,ISEASN,
     1   ISORCE) / CPCLUT(IPCLUT,ISEASN,IRECEP)) + BC(IPOLUT,ISEASN) *
     2   CS(IPOLUT,ISEASN,ISCRCE)
      CPOLUT(IPOLUT,ISEASN,IRECEP) = AC(IPOLUT,ISEASN) + BC(IPOLUT,
     1 ISEASN) * CPOLLT(IFOLUT,ISEASN,IRECEP)
C                 SPER = SCURCE CONT. % ; SCONT = SOURCE CONTRIBUTION.  SELECTO2
   60 SPER(I)=(CS(IPOLLT,ISEASN,ISORCE)/CPOLUT(IPOLUT,ISEASN,IRECEP))*
     1   100.
C  OUTPUT THE 5 RECEPTCR CATA                                           SELECTO2
C                                                                       SELECTO2
C  WRITE A DATA LINE                                                    SELECTO2
C                                                                       SELECTO2
      WRITE (6,999) ISCRCE, (SPER(I),I=1,KK)
C                     ICNT = NUMBER OF LINES WRITTEN PER PAGE.          SELECTO3
      ICNT = ICNT +1                                                    SELECTO3
C                                                                       SELECTO3
      IF (ICNT .LE. 4C) GC TO 70
C                                                                       SELECTO3
C   A PAGE IS FULL INITIALIZE FCR NEXT PAGE                             SELECTO3
C                                                                       SELECTO3
      ICNT = 0                                                          SELECTO3
C                                                                       SELECTO3
      WRITE (6,990) IPCLLT,ISEASN
      WRITE (6,991)
      WRITE (6,992) (ISEL5(IPOLLT,ISEASN,I),I=1,KK)
C                                                                       SELECTO3
   70 CONTINUE                                                          SELECTO2
C                                                                       SELECTO2
```

```
      SUBROUTINE SELECT                                                 SELECT01
C                                                                       SELECT01
      COMMON /AIRQ/DUM1(18),STANDV(3,3),DUM2(81),AVRGTM(5),AQSTAN(2,3,3)SELECT01
     1                  ,PERCNT(3)                                      SELECT01
      COMMON /DOL/IPOLL1,IPOLL2,ITIME1,ITIME2,ISKIPP,ISKIPT,INC(3,3)    SELECTO
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),OPOLUT(3,3,20),
     1              PTCON(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /RGSN/ AC(3,3),BC(3,3)
      COMMON /SELCT/ISEL12(3,3,12),NSEL12,ISEL5(3,3,5),NSEL5,XP(3,3,12) SELECT01
      COMMON /SRCE/ SOURCE(3,200),SINTEN(3,3,237),NSORCE,CS(3,3,200)
     1               ,IFLAG,JSIC(200),JSITE(200)
C                                                                       SELECT01
      DIMENSION SPER(5)
C                                                                       SELECT01
C  SUBROUTINE SELECT WILL CALL SEL12 IF 12 RECEPTORS HAVE BEEN SELECTED.SELECT01
C     IN ADDITION, 5 RECEPTORS ARE OUTPUTTED WITH THE PERCENTAGE  PER   SELECT01
C     SOURCE CONTRIBUTION FOR EACH POLLUTANT AND SEASON.                SELECT01
C     THESE 5 RECEPTORS ARE THE LARGEST CONCENTRATION POINTS OF THOSE   SELECT01
C     EXCEEDING THE AIR QUALITY STANDARDS OR THEY MAY BE SELECTED ON I/PSELECT01
C                                                                       SELECT01
C  TEST FOR 12 SELECTED RECEPTORS.                                      SELECT01
C                                                                       SELECT01
      IF (NSEL12 .EQ. 0) GO TO 50                                       SELECT01
      CALL SEL12                                                        SELECT01
C                                                                       SELECT01
C  COMPUTE SOURCE CONTRIBUTION PERCENTAGES.                             SELECT01
C                                                                       SELECT01
   50 DO 70 IPOLUT= IPOLL1,IPOLL2,ISKIPP
      DO 70 ISEASN= ITIME1,ITIME2,ISKIPT
C        ICNT IS THE LINE COUNT.
      ICNT  =  0
      KK= INC(IPOLUT,ISEASN)
C                                                                       SELECT02
C  SKIP PAGE AND WRITE HEADER LINE.                                     SELECT02
      WRITE(6,990) IPOLUT,ISEASN
      WRITE (6,991)
      IF (F(ISTAND,IPOLUT,ISEASN).LT..0001) F(ISTAND,IPOLUT,ISEASN)
     1   =.60/TTOTAL/AVTM
      CALL ZVALU1(F(ISTAND,IPOLUT,ISEASN),Z)
C GEOMETRIC MEAN
      GEOMN(ISTAND,IPOLUT,ISEASN)=AQSTAN(ISTAND,IPOLUT,ISEASN)/SIGG**Z
          WRITE (6,989) F(ISTAND,IPOLUT,ISEASN),Z,GEOMN(ISTAND,IPOLUT,
     1                   ISEASN),AQSTAN(ISTAND,IPOLUT,ISEASN)
  989     FORMAT (//T10,'F =',E10.5,T25,'Z =',E10.5,T50,'GEOMN =',E10.5,
     1              T75,'AQSTAN =',E10.5)
      GO TO 5901
C     ARITHMETIC MEAN
 5601 IF (JFLAG(ISTAND,IPOLUT,ISEASN).NE.1) GO TO  5602
      GEOMN(ISTAND,IPOLUT,ISEASN)=AQSTAN(ISTAND,IPOLUT,ISEASN)
 5901 ARIMN(ISTAND,IPOLUT,ISEASN)=GEOMN(ISTAND,IPOLUT,ISEASN)*SIGG**
     1       (.5*ALOG(SIGG))
          WRITE (6,990) GEOMN(ISTAND,IPOLUT,ISEASN),ARIMN(ISTAND,IPOLUT,
     1                   ISEASN)
  990     FORMAT (//T10,'GEOMN =',E10.5,T30,'ARIMN =',E10.5)
      GO TO 623
C     FOR ARITHMETIC MEAN INPUT
 5602 ARIMN(ISTAND,IPOLUT,ISEASN)=AQSTAN(ISTAND,IPOLUT,ISEASN)
      IF (JFLAG(ISTAND,IPOLUT,ISEASN).EQ.0) ARIMN(ISTAND,IPOLUT,ISEASN)=
     1        9.0E10
          WRITE (6,991) ARIMN(ISTAND,IPOLUT,ISEASN)
  991     FORMAT (//T10,'ARIMN =',E10.5)
  623 CONTINUE
C
C     SELECT SMALLER OF  THE TWO
C
 5603 STAND(IPOLUT,ISEASN)=ARIMN(1,IPOLUT,ISEASN)
      IF (ARIMN(1,IPOLUT,ISEASN).GT.ARIMN(2,IPOLUT,ISEASN)) STAND(IPOLUT
     1     ,ISEASN)=ARIMN(2,IPOLUT,ISEASN)
C
  624 CONTINUE
C
  625 CONTINUE
      RETURN
```

```
    1 DO 625 ISEASN=ITIME1,ITIME2,ISKIPT
      DO 624 IPOLLT=IPOLL1,IPOLL2,ISKIPP
      DO 623 ISTAND=1,2
          WRITE (6,986) ISEASN,IPOLUT,ISTAND
  986     FORMAT (T5,'SEASON =',I2//T5,'POLLUTANT =',I2//T5,'STANDARD ='
     1            I2)
      IF (AQSTAN(ISTAND,IPOLLT,ISEASN).GT..001) GO TO 1001
      WRITE (6,1002) ISTAND,IPOLLT,ISEASN
 1002 FORMAT (T5,'A/Q STANDARD VALUE IS ZERO FOR STANDARD ',I1,', POLLUT
     1ANT ',I1,', SEASON ',I1)
      GO TO 623
C
C     TTOTAL, LENGTH OF SAMPLING PERIOD, EQUALS 365 DAYS OR 8760 HRS.
C     FOR ANNUAL  AND 91 DAYS OR 2140 HRS. FOR SUMMER AND WINTER
C
 1001 TTOTAL=2190.
      IF (ISEASN.EQ.3) TTOTAL=8760.
C
C     TEST A/Q STANDARD AVERAGING TIME
C
      AVTM=AVTIME(ISTAND,IPOLUT,ISEASN)
      IF (ABS(AVTM-24.).LT..1) GO TO 5522
      AAA=(ALOG(TTOTAL/AVTM)/ALOG(TTOTAL/24.))**.500000
      SIGG=STANDV(IPOLLT,ISEASN)**AAA
          WRITE (6,987) AVTM,AAA,SIGG
  987     FORMAT (///T10,'AVTM =',F5.2,2X,'HRS',T40,'AAA =',F10.5,T55,
     1            'SIGG =',F10.5)
      GO TO 5523
 5522 SIGG=STANDV(IPOLLT,ISEASN)
          WRITE (6,988) JFLAG(ISTAND,IPOLUT,ISEASN)
  988     FORMAT(//T10,'JFLAG =',I2)
C     TEST STANDARD FORM
C
 5523 IF (JFLAG(ISTAND,IPOLLT,ISEASN).NE.3) GO TO 5601
C
C     TEST F, IF F.GT.0,A/Q STANDARD IS IN CMAX FORM,OTHERWISE % FORM
C
```

```
      WRITE (6,6001) REGION                                             DIFMOD2
      WRITE (6,6061)                                                    DIFMOD2
 6061 FORMAT (T20,'CONVERTED AND TRANSLATED DATA PRINT OUT')            DIFMOD2
      WRITE (6,6002) NLEFT                                              DIFMOD2
C     INITIALIZE LINE COUNTER                                           DIFMOD2
      LNCNT=9                                                           DIFMOD2
C     SET SGTDMX TO RETURN TO 65                                        DIFMOD2
      SGTDMX=.TRUE.                                                     DIFMOD2
      GO TO 300                                                         DIFMOD2
   65 ORIGIN (1)=X                                                      DIFMOD2
      ORIGIN (2)=Y                                                      DIFMOD2
   69 WRITE (6,6060)                                                    DIFMOD2
 6060 FORMAT (1H1)                                                      DIFMOD2
      XMIN=RBASE(1)                                                     DIFMOD2
      YMIN=RBASE(2)                                                     DIFMOD2
      XMAX=XMIN+(INCRX-1)*DELTA                                         DIFMOD2
      YMAX=YMIN+(INCRY-1)*DELTA                                         DIFMOD2
C                                                                       DIFMOD2
      WRITE (8,8060) XMIN,XMAX,YMIN,YMAX,DELTA,NRECEP                   DIFMOD2
 8060 FORMAT (' XMIN=',F10.3,' XMAX=',F10.3,' YMIN=',F10.3,' YMAX=',F10.DELTA
     13,' DELTA=',F10.3,' NRECEP=',I5)                                  DIFMOD2
C                                                                       DIFMOD2
C     PRE-PROCESS SOURCE-DATA                                           DIFMOD2
C                                                                       DIFMOD2
 2002 DO   80 ISORCE=1,NSORCE                                           DIFMOD2
C     CONVERT AREA TO DIAMETER OF EQUIVALENT CIRCLE                     DIFMOD2
      SOURCE(3,ISORCE)=1000.*SQRT(SOURCE(3,ISORCE)/PI4)                 DIFMOD2
C                                                                       DIFMOD2
C     MULTIPLY POLLUTANT TERMS                                          DIFMOD2
      DO   80 ISEASN=1,MXSESN                                           DIFMOD2
      DO   80 IPOLUT=1,MXPOL                                            DIFMOD2
   80 SINTEN(IPOLUT,ISEASN,ISORCE)=SINTEN(IPOLUT,ISEASN,ISORCE)*        DIFMOD2
     1          POLCON(IPOLUT)*10.5                                     DIFMOD2
C                                                                       DIFMOD2
C                                                                       DIFMOD2
C     CONVERT A/Q STANDARDS TO 24 HR. AVERAGING TIME
C
```

```
      WRITE (6,6C45) NRIGHT
 6045 FORMAT (T32,'SOURCE CCNCENTRATICN',T96,'RIGHT PAGE',I5,/,T14,'S U
     1M M E R',T31,'|',T39,'W I N T E R',T57,'|',T64,' A N N U A L')
      WRITE (6,6046) ABBREV, ABBREV, ABBREV
 6046 FORMAT (7X,6A4,T31,'|',3X,6A4,T57,'|',3X,6A4)
      WRITE (6,6000)                                                    DIFMOD2
      LNCNT=9                                                           DIFMOD2
      DO 50 ISORCE=1,NSORCE                                             DIFMOD2
      WRITE (6,6050) ((SINTEN(IPCLUT,ISEASN,ISORCE),IPOLUT=1,MXPOL),    DIFMOD2
     1                                              ISEASN=1,MXSESN)    DIFMOD2
 6050 FORMAT (T6,3F8.2,' |',3F8.2,' |',3F8.2)                           DIFMOD2
      LNCNT=LNCNT+1                                                     DIFMOD2
      IF(MOD(LNCNT ,3) .EC. C) WRITE (6,6000)                           DIFMOD2
      IF(LNCNT .LE. LINES) GC TO 50                                     DIFMOD2
      WRITE (6,6001) REGICN                                             DIFMOD2
      NRIGHT=NRIGHT+1                                                   DIFMOD2
      WRITE (6,6006)                                                    DIFMOD2
      WRITE (6,6C45) NRIGHT
      WRITE (6,6046) ABBREV, ABBREV, ABBREV
      WRITE (6,6000)                                                    DIFMOD2
      LNCNT=9                                                           DIFMOD2
   50 CONTINUE                                                          DIFMOD2
C     FINISH PAGE (RIGHT)                                               DIFMOD2
      IF(LNCNT .LT. 1C .OR. LNCNT .GT. LINES) GO TO 60                  DIFMOD2
      DO 55 LAT=LNCNT,LINES                                             DIFMOD2
      WRITE (6,6055)                                                    DIFMOD2
 6055 FORMAT (T31,'|',T57,'|')                                          DIFMOD2
      IF(MOD(LAT        ,3) .EQ. 2) WRITE (6,6000)                      DIFMOD2
   55 CONTINUE                                                          DIFMOD2
   60 IF(.NOT. REPLAY) GO TC 69                                         DIFMOD2
C     SAVE ORIGIN VALLES                                                DIFMOD2
      X=ORIGIN(1)                                                       DIFMOD2
      Y=ORIGIN(2)                                                       DIFMOD2
      ORIGIN(1)=0.0                                                     DIFMOD2
      ORIGIN(2)=0.0                                                     DIFMOD2
C     HEAD PAGE FOR REPLAY                                              DIFMOD2
      NLEFT=NLEFT+1                                                     DIFMOD2
```

```
C                                                                       DIFMOD2
C     TRANSLATE WRT ORIGIN                                              DIFMOD2
      SOURCE(1,ISORCE)=SOURCE(1,ISORCE)-ORIGIN(1)                       DIFMOD2
      SOURCE(2,ISORCE)=SOURCE(2,ISORCE)-ORIGIN(2)                       DIFMOD2
      LNCNT=LNCNT+1                                                     DIFMOD2
C     TEST FOR UNDERLINE                                                DIFMOD2
      IF(MOD(LNCNT ,3) .EQ. 0) WRITE (6,6000)                           DIFMOD2
C     TURN PAGE IF NECESSARY                                            DIFMOD2
      IF(LNCNT .LE. LINES) GO TO 25                                     DIFMOD2
      WRITE (6,6001) REGION                                             DIFMOD2
      WRITE (6,6006)                                                    DIFMOD2
      NLEFT=NLEFT+1                                                     DIFMOD2
      WRITE (6,6002) NLEFT                                              DIFMOD2
      WRITE (6,6020)                                                    DIFMOD2
      LNCNT=9                                                           DIFMOD2
      WRITE (6,6000)                                                    DIFMOD2
C                                                                       DIFMOD2
   25 CONTINUE                                                          DIFMOD2
C                                                                       DIFMOD2
 1141 IF(LNCNT .LT. 10 .OR. LNCNT .GT. LINES) GO TO 45                  DIFMOD2
C     FINISH PAGE (LEFT)                                                DIFMOD2
      DO 42 LAT=LNCNT,LINES                                             DIFMOD2
      WRITE (6,6004)                                                    DIFMOD2
 6004 FORMAT (T7,'|',T16,'|',T34,'|',T52,'|')                           DIFMOD2
C     WRITE A BLANK LINE                                                DIFMOD2
C           MOD(LAT+1,3) IS KEY FOR UNDERLINE WHEN EQUAL TO ZERO,       DIFMOD2
C     USE MOD(LAT,3)=2   SINCE MOD(LAT+1-1,3)=0+MOD(-1,3)               DIFMOD2
C     USE MOD(LAT,3)=2   SINCR MOD(LAT,3)    =  MOD(-1,3)  = 2          DIFMOD2
      IF(MOD(LAT       ,3) .EQ. 2) WRITE (6,6000)                       DIFMOD2
   42 CONTINUE                                                          DIFMOD2
      IF(SGTDMX) GO TO 65                                               DIFMOD2
C                                                                       DIFMOD2
C     WRITE SOURCE INTENSITIES                                          DIFMOD2
C  45     HEAD RIGHT PAGE                                               DIFMOD2
   45 WRITE (6,6001) REGION                                             DIFMOD2
      WRITE (6,6007)                                                    DIFMOD2
C     WRITE CONCENTRATION BANNER                                        DIFMOD2
```

```
      SOURCE(1,ISORCE)=FTTCKM*(SCURCE(1,ISORCE)-ORIGIN(1))              DIFMOD2
      SOURCE(2,ISORCE)=FTTCKM*(SCURCE(2,ISORCE)-ORIGIN(2))              DIFMOD2
C     CONVERT SQ.MI. TC SC. KM.                                         DIFMOD2
      SOURCE(3,ISORCE)=SMTCSK*SOURCE(3,ISORCE)                          DIFMOD2
      LNCNT=LNCNT+1                                                     DIFMOD2
C     TEST FOR UNDERLINE                                                DIFMOD2
      IF(MOD(LNCNT ,3) .EC. C) WRITE (6,6000)                           DIFMOD2
C     TURN PAGE IF NECESSARY                                            DIFMOD2
      IF(LNCNT .LE. LINES) GC TC 15                                     DIFMOD2
      WRITE (6,6001) REGICN                                             DIFMOD2
      WRITE (6,6006)                                                    DIFMOD2
      NLEFT=NLEFT+1                                                     DIFMOD2
      WRITE (6,6002) NLEFT                                              DIFMOD2
      WRITE (6,6010)                                                    DIFMOD2
C     INITIALIZE THE LINE CCUNTER                                       DIFMOD2
      LNCNT=9                                                           DIFMOD2
      WRITE (6,6000)                                                    DIFMOD2
   15 CONTINUE                                                          DIFMOD2
      GO TO 1
C
C     UTM CONVERSION
C     WRITE UTM BANNER                                                  DIFMOD2
  300 WRITE (6,6020)
 6020 FORMAT (T7,'|',T16,'|   HCRIZONTAL',4X,'|',4X,'VERTICAL',5X,'|',/,DIFMOD2
     1T7,'|',T16,'|',3X,'KILCMETERS',4X,'|',3X,'KILCMETERS',4X,'| SQUAREDIFMOD2
     2 KILOMETERS')
      WRITE (6,6000)                                                    DIFMOD2
C
C     TRANSLATE RBASE WRT ORIGIN
      RBASE(1)=RBASE(1)-ORIGIN(1)
      RBASE(2)=RBASE(2)-ORIGIN(2)
      DO 25 ISORCE=1,NSORCE                                             DIFMOD2
      L=1                                                               DIFMOD2
      IF(SOURCE(3,ISORCE) .LE. 0.) L=2                                  DIFMOD2
C     WRITE A UTM/STAKE DATA LINE                                       DIFMOD2
      WRITE (6,6015) ISORCE,(SOURCE(LAT,ISORCE),LAT=1,3),(APOINT(LON,L),DIFMOD2
     1 LON=1,4)                                                         DIFMOD2
```

```
      IF(LNCNT .LE. LINES) GC TC 5                                      DIFMOD2
      WRITE (6,6001) REGICN                                             DIFMOD2
      NLEFT=NLEFT+1                                                     DIFMOD2
C     WRITE (ONTINUED-                                                  DIFMOD2
      WRITE (6,6C06)                                                    DIFMOD2
 6006 FORMAT (T43,'CONTINLED')                                          DIFMOD2
      WRITE (6,6CC2) NLEFT                                              DIFMOD2
      WRITE (6,6003)                                                    DIFMOD2
      WRITE (6,6C00)                                                    DIFMOD2
C     INITIALIZE THE LINE CCUNTER                                       DIFMOD2
      LNCNT=9                                                           DIFMOD2
C                                                                       DIFMOD2
    5 CONTINUE                                                          DIFMOD2
      GO TO 1
C
  200 IF (UNITS .NE. STAKE) GC TC 300
C     KILOFOOT TO KILCMETER CCNVERSION
C
C     WRITE STAKE BANNER                                                DIFMOD2
      WRITE (6,6C10)
 6010 FORMAT (T7,'|',T16,'|   HCRIZONTAL',4X,'|',4X,'VERTICAL',5X,'|',/,DIFMOD2
     1T7,'|',T16,'|',4X,'KILCFEET',5X,'|',4X,'KILOFEET',5X,'| SQUARE MIL
     2ES')
      WRITE (6,6000)                                                    DIFMOD2
C     CONVER RBASE FRCM KFT TO KM AND TRANSLATE WRT CRIGIN
      RBASE(1)=FTTOKM*(RBASE(1)-CRIGIN(1))
      RBASE(2)=FTTOKM*(RBASE(2)-CRIGIN(2))
C     CONVERT STAKE (FEET, SC. MILES) TC UTM SYSTEM (KM.S)              DIFMOD2
      DO 15 ISORCE=1,NSCRCE                                             DIFMOD2
C                                                                       DIFMOD2
      L=1                                                               DIFMOD2
      IF(SOURCE(3,ISORCE) .LE. C.) L=2                                  DIFMOD2
C     WRITE A UTM/STAKE CATA LINE                                       DIFMOD2
      WRITE (6,6015) ISCRCE,(SCURCE(LAT,ISORCE),LAT=1,3),(APOINT(LON,L),DIFMOD2
     1 LON=1,4)                                                         DIFMOD2
 6015 FORMAT (T7,'|',I5,'    |',F12.3,5X,'|',F12.3,5X,'|',  F8.2,4A4)   DIFMOD2
C     CONVERT FEET TO KILCMETERS AND TRANSLATE WRT CRIGIN               DIFMOD2
```

```
      LATSEC=LAT-((LATDEG*10000)+(LATMIN*100))                          DIFMOD2
      ORIGIN(ISORCE)=1.0*LATDEG+(LATMIN+(LATSEC/6C.))/6C.               DIFMOD2
      IF(ISORCE .NE. 1) GC TO 3                                         DIFMOD2
      ISORCE=2                                                          DIFMOD2
      GO TO 2                                                           DIFMOD2
C     CONVERT LAT/LON TC LTM SYSTEM (KM.S)                              DIFMOD2
C                                                                       DIFMOD2
    3 DO 5 ISORCE=1,NSCRCE                                              DIFMOD2
C     CONVERT DDDMMSS TO CECIMAL PART OF DEGREE                         DIFMOD2
      LAT=IFIX(SCURCE(2,ISORCE))                                        DIFMOD2
      LATDEG=LAT/10000C                                                 DIFMOD2
      LATMIN=(LAT-(LATDEG*1C000))/100                                   DIFMOD2
      LATSEC=LAT-((LATDEG*10000)+(LATMIN*100))                          DIFMOD2
      SOURCE(2,ISORCE)=1.0*LATDEG+(LATMIN+(LATSEC/6C.))/60.             DIFMOD2
      LON=IFIX(SOURCE(1,ISORCE))                                        DIFMOD2
      LONDEG=LON/1000C                                                  DIFMOD2
      LONMIN=(LON-(LONDEG*1C0C0))/100                                   DIFMOD2
      LONSEC=LON-((LONDEG*1CC00)+(LONMIN*100))                          DIFMOD2
      SOURCE(1,ISORCE)=1.C*LONDEG+(LONMIN+(LONSEC/6C.))/60.             DIFMOD2
C                                                                       DIFMOD2
C     TRANSLATE WRT ORIGIN AND CCNVERT TO KILOMETERS FRCM DEGREES       DIFMOD2
      SOURCE(1,ISORCE)=CCNVER(1)*(SOURCE(1,ISORCE)-ORIGIN(1))           DIFMOD2
      SOURCE(2,ISORCE)=CCNVER(2)*(SOURCE(2,ISORCE)-CRIGIN(2))           DIFMOD2
C     TRANSLATE RBASE WRT ORIGIN AND CONVERT TO KM FRCM DEG.
      RBASE(1)=CONVER(1)*(RBASE(1)-ORIGIN(1))
      RBASE(2)=CONVER(2)*(RBASE(2)-ORIGIN(2))
C                                                                       DIFMOD2
      L=1                                                               DIFMOD2
      IF(SOURCE(3,ISORCE) .LE. 0.) L=2                                  DIFMOD2
C     WRITE A LAT/LON CATA LINE                                         DIFMOD2
      WRITE (6,6005) ISCRCE,LATDEG,LATMIN,LATSEC,LONDEG,LONMIN,LONSEC,  DIFMOD2
     1SOURCE(3,ISORCE),(APCINT(LON,L  ),LON=1,4)                        DIFMOD2
 6005 FORMAT (T7,'|',I5,'   |',3I5,'  |',3I5,'  |',  F8.2,4A4)          DIFMOD2
      LNCNT=LNCNT+1                                                     DIFMOD2
C     TEST FOR UNDERLINE                                                DIFMOD2
      IF(MOD(LNCNT ,3) .EC. C) WRITE (6,6000)                           DIFMOD2
C     TURN PAGE IF NECESSARY                                            DIFMOD2
```

```
C     SET LINES OF RECEPTOR CATA PEF PAGE                                     DIFMOD2
      NROWPG=LINES-8                                                          DIFMOD2
C     INITIALIZE RIGHT AND LEFT PAGE NUMBERS
      NRIGHT=1                                                                DIFMOD2
      NLEFT=1                                                                 DIFMOD2
C     INITIALIZE LINE CCLNTER (TC INCLUDE ALL BANNERS)                        DIFMOD2
      LNCNT =9                                                                DIFMOD2
C     WRITE LEFT-PAGE HEADER FCR SOURCE DATA                                  DIFMOD2
      WRITE (6,6001) REGICN                                                   DIFMOD2
 6001 FORMAT (1H1,T32,'S C U R C E   C A T A',//,T8,18A4)                      DIFMOD2
      WRITE (6,6007)                                                          DIFMOD2
 6007 FORMAT (1H )                                                            DIFMOD2
C     WRITE LOCATION BANNER                                                   DIFMOD2
      WRITE (6,6002) NLEFT                                                    DIFMOD2
 6002 FORMAT (T7,'| SCLRCE |',T27,'SCURCE LOCATION',T52,'|',8X,'SOURCE ADIFMOD2
     1REA',T96,'LEFT PAGE',I5,/,T7,'| NUMBER |',T52,'|')                       DIFMOD2
C     INITIALIZE SGTDMX FCR REPLAY USE                                        DIFMOD2
      SGTDMX=.FALSE.                                                          DIFMOD2
C
C     SELECT APPROPRIATE CCNVERSION MCDE
      IF (UNTS.EQ.K) GC TC 300
      IF (UNITS .NE. CEGREE) GC TO 20C
C
C     DEGREE TO KILOMETER CCNVERSICN
C     WRITE LAT/LON BANNER                                                    DIFMOD2
  10C WRITE (6,6CC3)                                                          DIFMOD2
 6003 FORMAT (T7,'|',T16,'|',4X,'LATITUDE',5X,'|',4X,'LCNGITUDE',4X,'|',DIFMOD2
     1/,T7,'|',T16,'|  CEG  MIN  SEC  |  DEG  MIN  SEC  | SQUARE KILCMETDIFMOD2
     2ERS')                                                                   DIFMOD2
C     UNDERLINE THE LAST LINE PRINTED                                         DIFMOD2
 6000 FORMAT (1H+,T7,'______________________________DIFMOD2
     1_______________')                                                       DIFMOD2
      WRITE (6,6000)                                                          DIFMOD2
      ISORCE=1                                                                DIFMOD2
    2 LAT=IFIX(ORIGIN(ISORCE))                                                DIFMOD2
      LATDEG=LAT/1000C                                                        DIFMOD2
      LATMIN=(LAT-(LATDEG*1CCCC))/10C                                         DIFMOD2
      SUBROUTINE CONVRT
C     ******************SPECIFICATION STATEMENTS***********************DIFMOD2
      LOGICAL SGTDMX                                                   DIFMOD2
C                 FCR SIGZ GREATER THAN DMIX -- A LCGICAL VARIABLE     DIFMOD2
      LOGICAL PNCH/.TRLE./                                             DIFMOD2
C                 FCR PLNCH - CR NCT PUNCH 1130 DECK                   DIFMOD2
      LOGICAL REPLAY/.FALSE./                                          DIFMOD2
C            ALLOW WRITING TC CCNVERTED DATA                           DIFMOD2
C
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3.3),
     1              STAND(3,3),ARIMN(2,3,3),GECMN(2,3,3),AVRGTM(5),
     2              AGSTAN(2,3,3),PERCNT(3)
      COMMON /CONS/ PI4,PI8,NCCLPG,NLEFT,NRIGHT
      COMMON /CORD/ CCNVER(2),ORIGIN(2),RBASE(2),DELTA,SMTOSK,FTTOKM,
     1              GCSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,QSCALE
      COMMON /DOL/ IPCLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /LITL/ ABBREV(6),REGION(18),APOINT(4,2),PNAME(6,3),
     1               PUNITS(5,3),SNAME(2,3),UNTS
      COMMON /LOGI/ SGTDMX,PNCH,REPLAY
      COMMON /MAX/  MXRECP,MXPOL,MXSESN,MXINTV
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),OPCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
      COMMON /RGSN/ AC(3,3),BC(3,3),CCRREL(25)
      COMMON /SELCT/ ISEL12(3,3,12),NSEL12,ISEL5(3,3,5),NSEL5,SELC12
     1              (3,3,12)
      COMMON /SRCE/ SCLRCE(3,200),SINTEN(3,3,237),NSCRCE,CS(3,3,200)
     1               ,IFLAG,JSIC(200),JSITE(200)
      COMMON /STAK/ HS(200),VS(200),DS(200),TS(200),PA, TA
      COMMON /WIND/ WCFREQ(16,3),SINWD(16),COSWD(16),DPTHMX(3),UW(16,3)
     1  ,SWC(6,16,3,5)
C     TRANSLATE THE CAMP STATICN COORDINATES WRT THE CRIGIN
      DO 2005 IRECEP=1,NRECEP
      RECEPT(1,IRECEP)=RECEPT(1,IRECEP)-ORIGIN(1)
 2005 RECEPT(2,IRECEP)=RECEPT(2,IRECEP)-ORIGIN(2)
C
```

```
C
      DATA  IPOLU1,IPOLU2/1,3/                                          DIFMOD2
      DATA  ISKIPP,ISKIPT/2*1/
C
C
      DATA  INCRX,INCRY/2*0/,DELTA,RBASE/3*0./                          DIFMOD2
C                                                                       DIFMOD2
      DATA  ITIME1,ITIME2/2*0/                                          DIFMOD2
C                                                                       DIFMOD2
      DATA  WDFREQ,DPTHMX/51*0./                                        DIFMOD2
      DATA  UW/48*0./                                                   DIFMOD2
C
      DATA  A,C,B/ 6*0./                                                DIFMOD2
      DATA  IADD/0/
      DATA  PERCNT /3*0./
      DATA  INC/9*0/
      END
```

```
C     VS(ISORCE)........STACK GAS VELCCITY IN METERS/SEC.
C     HS(ISORCE)........PHYSICAL STACK HEIGHT IN METERS
C     TA................AMBIANT TEMPERATURE IN DEG-F
C     PA................AMBIANT PRESSURE IN MILIBARS
C     DS(ISORCE)........STACK CIAMETER IN METERS
C
      DATA APOINT/'                    A PCINT SOURCE'/                  DIFMOD2
C                                                                        DIFMOD2
      DATA POLCON/350.16,8C0.35,1.0/                                     DIFMOD2
C                                                                        DIFMOD2
      DATA ZMIN,ZMAX/9*9.CE+1C,9*-9.0E+10/                               DIFMOD2
C                                                                        DIFMOD2
      DATA NCOLPG/5/                                                     DIFMOD2
C                                                                        DIFMOD2
      DATA PUNITS/'PARTS PER MILLION   PARTS PER MILLICN   MICROGRAMS/CU DIFMOD2
     1. METER'/
C                                                                        DIFMOD2
      DATA PNAME/'  SCX (HALF LIFE=3 HRS)     CARBCN MONOXIDE            DIFMOD2
     1 PARTICULATE      '/
C
      DATA MXRECP,MXPCL,MXSESN/237,3,3/                                  DIFMOD2
      DATA MXINTV/5/
C                                                                        DIFMOD2
      DATA QSCALE,GDSCAL/1.C,1CCC./                                      DIFMOD2
C                                                                        DIFMOD2
      DATA LINES,NLEFT,NRIGHT/53,1,1/                                    DIFMOD2
C                                                                        DIFMOD2
C                                                                        DIFMOD2
      DATA AC/9*C.0/,BC/9*1.0/
      DATA SNAME/' SUMMER  WINTER  ANNUAL '/
      DATA ABBREV/'  SCX      CO     PART  '/
C
      DATA REGION/18*'    '/                                             DIFMOD2
C                                                                        DIFMOD2
      DATA NSORCE/0/                                                     DIFMOD2
C                                                                        DIFMOD2
      DATA UNITS/'KMKM'/,CCNVER/2*1./,ORIGIN/2*0./                       DIFMOD2
                                                                         DIFMOD2
```

```
C      SOURCE(2,ISORCE)=  VERTICAL COMPONENT OF SCURCE                   DIFMOD2
C      SOURCE(3,ISORCE)=AREA CF SCURCE (CONVERTED TC CIAMETER OF         DIFMOD2
C                                               EQUIVALENT CIRCLE)       DIFMOD2
C
       DATA SINTEN/180C*0./
C      SINTEN(IPOLUT,ISEASN,ISORCE)                                      DIFMOD2
C                                                                        DIFMOD2
       DATA CS/18CC*C./
       DATA CPOLUT/2133*0./
       DATA RECEPT /474*C./
C      RECEPTOR(1,IRECEP)=HORIZCNTAL CCMPONENT OF RECEPTOR               DIFMOD2
C      RECEPTOR(2,IRECEP)=  VERTICAL CCMPONENT OF RECEPTOR               DIFMOD2
C                                                                        DIFMOD2
       DATA CEGREE,STAKE,LTM/'LTLN','FTMI','KMKM'/                       DIFMOD2
C      UNITS='LTLN' IMPLIES LATITUDE/LCNGITUDE MODE CF CONVERSION NEEDED DIFMOD2
C      UNITS='FTMI' IMPLIES STAKE (FEET/MILES) MODE CF CONVERSION NEEDED DIFMOD2
C      UNITS ='KMKM' IMPLIES UTM (KMTR/KMTR2) MODE OF CONVERSION NEEDED  DIFMOD2
C                                                                        DIFMOD2
       DATA FTTOKM,SMTCSK/.3C4801,2.590074/
C      FTTOMT=KILOFOOT TC KILCMETER CONVERSION
C      SMTOSK=SQUARE MILE TC SQUARE KILOMETER CONVERSION                 DIFMOD2
C                                                                        DIFMOD2
       DATA COSWD/1.C,.92388,.7C711,.38268,0.0,-.38268,-.70711,-.92388,  DIFMOD2
     1    -1.0,-.92388,-.7C711,-.38268,0.0,.38268,.7C711,.92388/         DIFMOD2
C                                                                        DIFMOD2
C      COSWD(IWNDIR)=SIN((PI*FLCAT(IWNDIR-1))/8)                         DIFMOD2
C                                                                        DIFMOD2
       DATA SINWD/0.C,.38268,.7C711,.92388,1.C,.92388,.70711,.38268,0.C, DIFMOD2
     1    -.38268,-.7C711,-.92388,-1.0,-.92388,-.70711,-.38268/          DIFMOD2
C                                                                        DIFMOD2
C      SINWD(IWNDIR)=SIN((PI*FLCAT(IWNDIR-1))/8)                         DIFMOD2
C                                                                        DIFMOD2
       DATA PI4,PI8/.7853982,.3926991/                                   DIFMOD2
C                                                                        DIFMOD2
       DATA HS/20C*75./
       DATA VS,DS,TS/6CC*C./
C      TS(ISORCE)........STACK GAS TEMPERATURE IN DEG. F.
```

```
      BLOCK DATA
C                                                                       DIFMOD2
C     *******************SPECIFICATION STATEMENTS************************DIFMOD2
      LOGICAL SGTDMX                                                    DIFMOD2
C                 FCR SIGZ GREATER THAN DMIX -- A LOGICAL VARIABLE      DIFMOD2
      LOGICAL PNCH/.TRUE./                                              DIFMOD2
C                 FCR PUNCH - CR NCT PUNCH 1130 DECK                    DIFMOD2
      LOGICAL REPLAY/.FALSE./                                           DIFMOD2
C             ALLOW WRITING TO CCNVERTED DATA                           DIFMOD2
C
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              AQSTAN(2,3,3),PERCNT(3)
      COMMON /CONS/ PI4,PI8,NCCLPG,NLEFT,NRIGHT
      COMMON /CORD/ CCNVER(2),ORIGIN(2),RBASE(2),DELTA,SMTOSK,FTTOKM,
     1              GCSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,QSCALE
      COMMON /DOL/ IPCLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT,INC(3,3)
      COMMON /LITL/ ABBREV(6),REGION(18),APOINT(4,2),PNAME(6,3),
     1               FUNITS(5,3),SNAME(2,3),UNTS
      COMMON /LOGI/ SGTCMX,PNCH,REPLAY
      COMMON /MAX/  MXRECP,MXPOL,MXSESN,MXINTV
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),OPCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
      COMMON /RGSN/ AC(3,3),BC(3,3),CORREL(25)
      COMMON /SELCT/ ISEL12(3,3,12),NSEL12,ISEL5(3,3,5),NSEL5,SELC12
     1              (3,3,12)
      COMMON /SRCE/ SCURCE(3,2CC),SINTEN(3,3,237),NSCRCE,CS(3,3,200)
     1               ,IFLAG,JSIC(200),JSITE(200)
      COMMON /STAK/ HS(20C),VS(2C0),DS(200),TS(200),PA,TA
      COMMON /WIND/ WCFREQ(16,3),SINWD(16),COSWD(16),DPTHMX(3),UW(16,3)
     1  ,SWC(6,16,3,5)
C
C     ************************DATA STATEMENTS****************************DIFMOD2
      DATA SOURCE /60C*0./
C     SOURCE(1,ISORCE)=HCRIZCNTAL COMPCNENT OF SOURCE                   DIFMOD2
```

```
6000 FORMAT (1H+,T7,'___________________________________________________DIFMOD2
    1_______________________')
     RETURN
     END
```

```
61025 FORMAT (1H1,T30,'R E C E P T O R   D A T A',//,T8,18A4,//,T8,       DIFMOD2
     1'AVERAGE CONCENTRATICNS CF ',6A4,' FCR THE',2A4,'SEASON', /,T7,     DIFMOD2
     2'PAGE NO.',I3,'  DISTANCES IN KILOMETERS, CONCENTRATIONS IN ',5A4,DIFMOD2
     3/,T7,'ORDINATE |',T45,'ABCISSA')                                    DIFMOD2
      WRITE (6,6000)                                                      DIFMOD2
      NPAGE=NPAGE+1                                                       DIFMOD2
      LATDEG=1+INCRY*(LCN-1)                                              DIFMOD2
      LONDEG=1+INCRY*(LCN+NCOLPG-2)
      IF(LONDEG .GT. NRECEP) LCNCEG=NRECEP                                DIFMOD2
      WRITE  (6,61050) (RECEPT(1,L),L=LATDEG,LCNDEG,INCRY)
61C50 FORMAT (T16,'|',5( F12.3,'|'))                                      DIFMOD2
      WRITE (6,6C00)                                                      DIFMOD2
C                                                                         DIFMOD2
C     LOOP ON ROWS                                                 LATDEG DIFMOD2
C                                                                         DIFMOD2
      DO  1400 LATDEG=1,NROWPG                                            DIFMOD2
      LATMIN=LAT+LATDEG-1                                                 DIFMOD2
      IF(LATMIN .GT. INCRY) GO TC 1300                                    DIFMOD2
C     PRINT A LINE OF CATA                                                DIFMOD2
      LATSEC=INCRY+1-LATMIN                                               DIFMOD2
      LONMIN=LATMIN+INCRY*(LCN-1)                                         DIFMOD2*
      LONSEC=LATMIN+INCRY*(LON+NCOLPG-2)                                  DIFMOD2*
      WRITE (6,61075) RECEPT(2,LATDEG),(CPOLUT(IPOLUT,ISEASN,IRECEP),     DIFMOD2
     1    IRECEP=LONMIN,LCNSEC,INCRY)                                     DIFMOD2
61075 FORMAT (T7,F9.2,'|',5(E12.5,'|'))                                   DIFMOD2
      GO TO 1350                                                          DIFMOD2
C     PRINT BLANK LINE                                                    DIFMOD2
 1300 WRITE (6,61300)                                                     DIFMOD2
61300 FORMAT (T16,'|',T29,'|',T42,'|',T55,'|',T68,'|',T81,'|')            DIFMOD2
C     UNDERLINE IF DESIREC                                                DIFMOD2
 1350 IF(MOD(LATDEG,3) .EC. C) WRITE (6,6000)                             DIFMOD2
 1400 CONTINUE                                                            DIFMOD2
C                                                                         DIFMOD2
C     END OF ALL PRINTING LCCPS                                           DIFMOD2
C                                                                         DIFMOD2
 1450 CONTINUE
 1500 CONTINUE
```

```
      SUBROUTINE PRINTZ
      COMMON /CONS/ PI4,PI8,NCCLPG,NLEFT,NRIGHT
      COMMON /CORD/ CCNVER(2),ORIGIN(2),RBASE(2),DELTA,SMTCSK,FTTOKM,
     1              GCSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,QSCALE
      COMMON /DOL/IPOLU1,IPCLU2,ITIME1,ITIME2,ISKIPP,ISKIPT,INC(3,3)    SELECTO
      COMMON /LITL/ ABBREV(6),REGION(18),APOIN(4,2),PNAME(6,3),
     1               PUNITS(5,3),SNAME(2,3),UNTS
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),OPCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
C     ************************PRINT OUT  RECEPTOR DATA******************DIFMOD2
      NCCLPG=5
      NRCWPG=LINES-8
C                                                                       DIFMOD2
C     LOOP ON SEASON                                             ISEASN DIFMOD2
C                                                                       DIFMOD2
      DO  1500 ISEASN=ITIME1,ITIME2,ISKIPT                              DIFMOD2
C                                                                       DIFMOD2
C     LOOP ON POLLUTANT                                          IPOLUT DIFMOD2
C                                                                       DIFMOD2
      DO  1500 IPCLUT=IPCLU1,IPCLU2,ISKIPP
C     INITIALIZE PAGE NUMBER                                            DIFMOD2
      NPAGE=1                                                           DIFMOD2
C                                                                       DIFMOD2
C     LOOP ON VERTICAL SPREAD (IF LINES/PAGE .LT. INCRY)          LAT   DIFMOD2
C                                                                       DIFMOD2
      DO  1450 LAT=1,INCRY,NRCWPG                                       DIFMOD2
C                                                                       DIFMOD2
C     LOOP ON HORIZONTAL SPREAD (WHEN COLUMNS/PAGE .LT. INCRX)    LON   DIFMOD2
C                                                                       DIFMOD2
      DO  1450 LON=1,INCRX,NCCLPG                                       DIFMOD2
      IRECEP=INCRY-LAT+1                                                DIFMOD2
C     HEAD A PAGE                                                IRECEP DIFMOD2
      WRITE (6,61025) REGION,(PNAME(L,IPOLUT),L=1,6),                   DIFMOD2
     1                       (SNAME(L,ISEASN),L=1,2),NPAGE,             DIFMOD2
     3                       (PUNITS(L,IPOLUT),L=1,5)                   DIFMOD2
```

```
      RETURN
C     IMPROPER NUMBER CF SEASCNS
   32 WRITE (6,6032) ITIME1,ITIME2,MXSESN                               DIFMOD2
 6032 FORMAT (' * * * NUMBER OF SEASONS NOT WITHIN ACCEPTABLE BOUNDS FRCDIFMOD2
     1M SEASON ',I3,' TC SEASON ',I3,' NOT BETWEEN C AND ',I3,' READ FORDIFMOD2
     2 NEXT CASE')                                                      DIFMOD2
      RETURN
C     IMPROPER GRID SPECS
   33 WRITE (6,6033) INCRX, INCRY, DELTA                                DIFMOD2
 6033 FOPMAT (1HO,' *** EITHER INCRX (',I5,'), INCRY (',I5,'), OR DELTA DIFMOD2
     1(',F7.2,') IS ZERC.  REAC NEXT DATA SET. * * ')                   DIFMOD2
      RETURN
C     TOO MANY RECEPTCR PCINTS                                          DIFMOD2
   34 WRITE (6,6034) INCRX,INCRY,MXRECP                                 DIFMOD2
 6034 FORMAT (1HO,' * * TCC MANY RECEPTORS (',I3,'*',I3,'.GT.',I4,')',/)DIFMOD2
      RETURN
   35 WRITE (6,6035)                                                    DIFMOD2
 6035 FORMAT (1H1,' ENC OF FILE ENCOUNTERED -- TERMINATE RUN.')         DIFMOD2
      RETURN
      END
     1    UNITS,CONVEF,CRIGIN,IPOLU1,IPOLU2,F,STAND,AVRGTM,ACSTAN,
     2    POLCON,PNAME,PUNITS,ISKIPP,ISKIPT,PERCNT,ISEL12,NSEL12,ISEL5,
     3    INCRX,INCRY,DELTA,RBASE,NRECEP,RECEPT,NSEL5,
     4    ITIME1,ITIME2,SNAME,IFLAG,XRECEP,IADD,
     5    WDFREQ,DPTHMX,UW, CORREL,UU,
     6    A,B,C,OPOLUT,SWC,
     8    PNCH,REPLAY,LINES,
     9    HS,VS,DS,TS,TA,PA
C     READ THE NAMELIST 'INDATA'                                        DIFMOD2
    1 READ (5,INDATA,END=35)                                            DIFMOD2
      WRITE (9,INDATA)
      NPOLUT=IPOLU2-IPCLL1+1
      IF(NPOLUT .LE. C .OF. NPOLUT .GT. MXPOL) GO TC 31                 DIFMOD2
      IF(ITIME1 .LE. C .CF. ITIME1 .GT. MXSESN .OR.                     DIFMOD2
     1   ITIME2 .LE. C .OF. ITIME2 .GT. MXSESN .OR. ITIME1 .GT. ITIME2) DIFMOD2
     2            GO TC 32                                              DIFMUD2
C                                                                       DIFMOD2
C     TEST INCRX, INCRY, AND DELTA -- IF ANY .EQ. ZERC, READ NEXT CASE  DIFMOD2
      IF((FLOAT(INCRX-1)*FLCAT(INCRY-1)*DELTA) .LE. 0.0) GO TO 33       DIFMOD2
C     TEST NUMBER OF CRID PCINTS                                        DIFMOD2
      NRECP=INCRX*INCRY
C                                                                       DIFMOD2
 2000 IF(NRECP .LE. C .CR. NRECP .GT. MXRECP) GO TC 34
C
C     DIAGNOSTIC SITUATICNS AT INPUT                                    DIFMOD2
C
      IF (UNITS.EQ.CEGREE.OR.UNITS.EQ.STAKE.OR.UNITS.EQ.UTM) RETURN
C
C     UNKNOW LOCATICN UNITS                                             CIFMOD2
   3C WRITE (6,6030) UNITS                                              DIFMOD2
 6030 FORMAT (1HO,' * * INPUT LCCATICN UNITS (',1A4,') UNRECOGNIZED.',/,DIFMOD2
     1'   WILL TRY TO READ FOR NEXT DATA SET.  * *')                    DIFMOD2
      RETURN
C     IMPROPER NUMBER CF PCLLUTANTS
   31 WRITE (6,6031) NPCLLT,MXPCL                                       DIFMOD2
 6031 FORMAT (' * * * NUMBER OF POLLUTANTS NOT WITHIN ACCEPTABLE BOUNDS,DIFMOD2
     1 ',I3,' IS NOT BETWEEN C AND ',I3,', READ FOR NEXT DATA SET.')    DIFMOD2
```

```
      SUBROUTINE INPUT
C     ******************SPECIFICATION STATEMENTS***********************DIFMOD2
      LOGICAL SGTDMX                                                    DIFMOD2
C                FOR SIGZ GREATER THAN DMIX -- A LCGICAL VARIABLE       DIFMOD2
      LOGICAL PNCH/.TRUE./                                              DIFMOD2
C                FCR PLNCH - OR NOT PUNCH 1130 DECK                     DIFMOD2
      LOGICAL REPLAY/.FALSE./                                           DIFMOD2
C           ALLOW WRITING TO CCNVERTED DATA                             DIFMOD2
C
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              ACSTAN(2,3,3),PERCNT(3)
      COMMON /CONS/ PI4,PI8,NCCLFG,NLEFT,NRIGHT
      COMMON /CORD/ CCNVER(2),ORIGIN(2),RBASE(2),DELTA,SMTOSK,FTTOKM,
     1              GCSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,OSCALE
      COMMON /DOL/ IPCLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /LITL/ ABBREV(6),REGICN(18),APOINT(4,2),PNAME(6,3),
     1               PUNITS(5,3),SNAME(2,3),UNTS
      COMMON /LOGI/ SGTCMX,PNCH,REPLAY
      COMMON /MAX/  MXRECP,MXPCL,MXSESN,MXINTV
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),OPCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
      COMMON /RGSN/ AC(3,3),BC(3,3),CCRREL(25)
      COMMON /SELCT/ ISEL12(3,3,12),NSEL12,ISEL5(3,3,5),NSEL5,SELC12
     1              (3,3,12)
      COMMON /SRCE/ SCURCE(3,2CC),SINTEN(3,3,237),NSCRCE,CS(3,3,200)
     1               ,IFLAG,JSIC(200),JSITE(200)
      COMMON /STAK/ HS(2CC),VS(200),DS(200),TS(20C),PA,TA
      COMMON /WIND/ WDFREG(16,3),SINWD(16),COSWD(16),DPTHMX(3),UW(16,3)
     1              ,SWC(6,16,5,3),UU(6)
C
C                                                                       DIFMOD2
C     NAMELIST INDATA LIST CF DATA TO BE ENTERED************************DIFMOD2
C                                                                       DIFMOD2
      NAMELIST /INDATA/ REGICN,NSCRCE,SCURCE,SINTEN,AVTIME,STANDV,JFLAG,
C
      REDUCA(IPOLUT,ISEASN,I)=EXCESS(IPOLUT,ISEASN,I)/CTEMP
     1(IPOLUT,ISEASN,I)*100.
C
C     NECESSARY REDUCTION FOR POINT SOURCES ONLY IN %
C
      REDUCP(IPOLUT,ISEASN,I)= EXCESS(IPOLUT,ISEASN,I)/
     1                            PTCON(IPOLUT,ISEASN,K)*100.
      WRITE(6,1969) JRECEP(IPOLUT,ISEASN,I),CTEMP(IPOLUT,ISEASN,
     1I),EXCESS(IPOLUT,ISEASN,I),PTCON(IPOLUT,ISEASN,K),
     2AREACP(IPOLUT,ISEASN,I),REDUCP(IPOLUT,ISEASN,I),
     3REDUCA(IPOLUT,ISEASN,I)
 1969 FORMAT (/T7,I3,4(8X,E12.5),2(8X,F12.5))
      LINECN=2+LINECN
      IF (LINECN.LT.40) GO TO 100
      LINECN=0
      WRITE (6,1849)
      WRITE (6,1850) IPOLUT,ISEASN,STAND(IPOLUT,ISEASN)
      WRITE (6,1970)
      WRITE (6,1968)
  100 CONTINUE
      WRITE (6,1970)
    9 CONTINUE
C
   10 CONTINUE
      RETURN
      END
      KKK=INC(IPOLUT,ISEASN)
      DO 499 K=1,KKK
  499 ISFL5(IPOLUT,ISEASN,K)=JRECEP(IPOLUT,ISEASN,K)
C
C     STORE EXCESS COUNTER
C
  501 ICOUNT(IPOLUT,ISEASN)=INCREM
      LINECN=0
C
      WRITE (6,1849)
 1849 FORMAT ('1'/)
      WRITE(6,1951)
 1951 FORMAT (T40,'POLLUTANT CONCENTRATIONS ABOVE STANDARD',//)
      WRITE (6,1850) IPOLUT,ISEASN,STAND(IPOLUT,ISEASN)
 1850 FORMAT (T3,'POLLUTANT ',I1//T3,'SEASON ',I1//T3,'AIR QUALITY STAND
     1ARD =',E12.5)
      WRITE (6,1970)
 1970 FORMAT (33('____'))
      WRITE (6,1968)
 1968 FORMAT (T2,'|','RECEPTOR |  ARITHMETIC MEAN  | EXCESS ABOVE AIR  |
     1 CONTRIBUTION FROM | CONTRIBUTION FROM |NECESSARY REDUCTION|NECESS
     2ARY REDUCTION|'/'|  NUMBER   |   CONCENTRATION   | QUALITY STANDARD
     3  |    POINT SOURCES    |    AREA SOURCES     | FOR POINT SOURCES |  F
     4OR ALL SOURCES'/'+'33('____'))
C     COMPUTE EXCESS ABOVE STANDARD
      IF (INCREM.GT.50) INCREM=50
      DO 100 I=1,INCREM
 1971 EXCESS(IPOLUT,ISEASN,I)=CTEMP(IPOLUT,ISEASN,I)-AIRQTY
      K=JRECEP(IPOLUT,ISEASN,I)
C
C     COMPUTE AREA SOURCE CONTRIBUTION FROM TOTAL CONCENTRATION AND
C     POINT SOURCE CONTRIBUTION
C
      AREACP(IPOLUT,ISEASN,I)=CTEMP(IPOLUT,ISEASN,I)-PTCON
     1(IPOLUT,ISEASN,K)
C
C     NECESSARY REDUCTION FOR ALL SOURCES IN %
```

```
C
      IF (NSEL12.NE.1) GO TO 500
      DO 400 I=1,12
      IRECEP=ISEL12(IPOLUT,ISEASN,I)
  400 SELC12(IPOLUT,ISEASN,I)= CPOLUT(IPOLUT,ISEASN,IRECEP)
  500 AIRQTY=STAND(IPOLUT,ISEASN)
      INCREM=0
      DO   8 IRECEP=1,NRECEP
C
C     COMPARE GROUND LEVEL CONCENTRATION AND STANDARD
C
      IF (CPOLUT(IPOLUT,ISEASN,IRECEP).LE.AIRQTY) GO TO 8
      INCREM=INCREM+1
C
C     STORE RECEPTOR NUMBERS AND EXCEEDING CONCENTRATION VALUES
C
      JRECEP(IPOLUT,ISEASN,INCREM)= IRECEP
      CTEMP(IPOLUT,ISEASN,INCREM)=CPOLUT(IPOLUT,ISEASN,IRECEP)
C
    8 CONTINUE
C
C     SORT THE EXCEEDING VALUES IN DESCENDING ORDER
C
      DO 1501 I=1,INCREM
      TEMP1(I)=CTEMP(IPOLUT,ISEASN,I)
 1501 TEMP2(I)=JRECEP(IPOLUT,ISEASN,I)
      CALL ORDER (INCREM,TEMP1,TEMP2)
      DO 502 I=1,INCREM
      CTEMP(IPOLUT,ISEASN,I)=TEMP1(I)
  502 JRECEP(IPOLUT,ISEASN,I)=TEMP2(I)
C
C     TEST NSEL5, IF NOT 1, STORE RECEPTOR NUMBERS OF 5 MAX CPOLUT
C     IN ISEL5(3,3,5)
C
      IF (NSEL5.EQ.1) GO TO 501
      INC(IPOLUT,ISEASN)=5
      IF (INCREM.LT.5) INC(IPOLUT,ISEASN)=INCREM
      SUBROUTINE EXCEED
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              ACSTAN(2,3,3),PERCNT(3)
      COMMON /CONS/ PI4,PI8,NCOLPG,NLEFT,NRIGHT
      COMMON /CORD/ CONVER(2),ORIGIN(2),RBASE(2),DELTA,SMTOSK,FTTOKM,
     1              GDSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,QSCALE
      COMMON /DOL/IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT,INC(3,3)     SELECTO
      COMMON /LITL/ ABBREV(6),REGION(18),APOINT(4,2),PNAME(6,3),
     1               PUNITS(5,3),SNAME(2,3),UNTS
      COMMON /LOGI/ SGTCMX,PNCH,REPLAY
      COMMON /MAX/  MXRECP,MXPOL,MXSESN,MXINTV
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),OPOLUT(3,3,20),
     1              PTCON(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
      COMMON /RGSN/ AC(3,3),BC(3,3),CORREL(25)
      COMMON /SELCT/ ISEL12(3,3,12),NSEL12,ISEL5(3,3,5),NSEL5,SELC12
     1              (3,3,12)
      COMMON /SRCE/ SOURCE(3,200),SINTEN(3,3,237),NSCRCE,CS(3,3,200)
     1               ,IFLAG,JSIC(200),JSITE(200)
      COMMON /STAK/ HS(200),VS(200),DS(200),TS(200),PA,TA
      COMMON /WIND/ WDFREQ(16,3),SINWD(16),COSWD(16),DPTHMX(3),UW(16,3)
      EQUIVALENCE (CPOLUT(1,1,1), CTEMP(1,1,1))
      DIMENSION CTEMP(3,3,237),ICOUNT(3,3),EXCESS(3,3,50),AREACP(3,3,50)
     1              ,REDUCA(3,3,50),REDUCP(3,3,50)
      DIMENSION TEMP1(200),TEMP2(200)
      DO 77 I=1,3
   77 STAND(1,I)=.00075000
      DO 78 I=1,3
   78 STAND(2,I)=.0250000
      DO 79 I=1,3
   79 STAND(3,I)=.0000007500
      DO 10 ISEASN=ITIME1,ITIME2,ISKIPT
      DO  9 IPOLUT=IPOLU1,IPOLU2,ISKIPP
C
C     STORE 12 CPOLUT VALUES IF NSEL12=1
```

END

```
   20 XRECEP(2,J)=RECEPT(2,J)
      IRECEP=0
C
C     CREATE A RECEPTOR GRID WITH ORIGIN AT RBASE                       DIFMOD2
      X=RBASE(1)                                                        DIFMOD2
      DO  75 LAT=1,INCRX                                                DIFMOD2
      Y=RBASE(2)                                                        DIFMOD2
      DO  70 LON=1,INCRY                                                DIFMOD2
      IRECEP=IRECEP+1                                                   DIFMOD2
      RECEPT(1,IRECEP)=X                                                DIFMOD2
      RECEPT(2,IRECEP)=Y                                                DIFMOD2
   70 Y=Y+DELTA                                                         DIFMOD2
   75 X=X+DELTA                                                         DIFMOD2
C
C     RESET NRECEP
      NRECEP=INCRX*INCRY
      IF (IADD .EQ. 0) GO TO 150
      DO 100 I = 1,IADD
      RECEPT(1,(NRECEP+I)) = XRECEP(1,I)
      RECEPT(2,(NRECEP+I)) = XRECEP(2,I)
  100 CONTINUE
      NRECEP=NRECEP + IADD
C     WRITE INDEX RECORD
      WRITE(12) IPOLU1,IPOLU2,ISKIPP,NRECEP,NSORCE,(STAND(K,3),K=1,3)
C
C
  150 DO 9955 IRECEP=1,NRECEP
      CALL POLUT
 9955 CONTINUE
      CALL PRINTZ
      IF (.NOT.PNCH) GO TO 9956
      NRECEP = NRECEP - IADD
      CALL PLOT
      NRECEP = NRECEP + IADD
 9956 CONTINUE
      CALL EXCEED
      RETURN
      SUBROUTINE DIFMCD
C
C     *******************SPECIFICATION STATEMENTS************************DIFMOD2
      LOGICAL SGTDMX                                                    DIFMOD2
C                FCR SIGZ GREATER THAN DMIX -- A LCGICAL VARIABLE       DIFMOD2
      LOGICAL PNCH/.TRUE./
C                FCR PLNCH - CR NCT PUNCH 1130 DECK
      LOGICAL REPLAY/.FALSE./
C             ALLOW WRITINC TC CONVERTED DATA
C
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              ACSTAN(2,3,3),PERCNT(3)
      COMMON /CONS/ PI4,PI8,NCCLPG,NLEFT,NRIGHT
      COMMON /CORD/ CCNVER(2),CRIGIN(2),RBASE(2),DELTA,SMTOSK,FTTOKM,
     1              GCSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,QSCALE
      COMMON /DOL/ IPOLU1,IPCLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /LITL/ ABBREV(6),REGION(18),APOIN(4,2),PNAME(6,3),
     1               PUNITS(5,3),SNAME(2,3),UNTS
      COMMON /LOGI/ SGTDMX,PNCH,REPLAY
      COMMON /MAX/  MXRECP,MXPOL,MXSESN,MXINTV
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),OPCLUT(3,3,20),
     1             PTCCN(3,3,237),NRECEP ,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
      COMMON /RGSN/ AC(3,3),BC(3,3),CCRREL(25)
      COMMON /SELCT/ ISEL12(3,3,12),NSEL12,ISEL5(3,3,5),NSEL5,SELC12
     1              (3,3,12)
      COMMON /SRCE/ SCURCE(3,20C),SINTEN(3,3,237),NSCRCE,CS(3,3,200)
     1               ,IFLAG,JSIC(200),JSITE(200)
      COMMON /STAK/ HS(20C),VS(200),DS(200),TS(200),PA,TA
      COMMON /WIND/ WDFREC(16,3),SINWD(16),COSWD(16),DPTHMX(3),UW(16,3)
C
      CALL CAMP
C     TEMPORARILY SET THE 12 SELECTED RECEPTORS = CAMP STATIONS
      DO 20 J=1,IADD
      XRECEP(1,J)=RECEPT(1,J)
     1   ZMAX(IPOLUT,ISEASN)    =  CPOLUT(IPOLUT,ISEASN,IRECEP)          DIFMOD2
  820 CONTINUE                                                           DIFMOD2
  900 CONTINUE                                                           DIFMOD2
      RETURN
      END
      DO 520 ISEASN=ITIME1,ITIME2,ISKIPT
      DO 520 IPOLUT=IPOLU1,IPOLU2,ISKIPP
      PTCON(IPOLUT,ISEASN,IRECEP) = AC(IPOLUT,ISEASN) * (PTCON(IPOLUT,
     1     ISEASN,IRECEP) / CPOLUT(IPOLUT,ISEASN,IRECEP)) + BC(IPOLUT,
     2   ISEASN) * PTCON(IPOLUT,ISEASN,IRECEP)
      DO 510 ISORCE=1,NSORCE
  510 CS(IPOLUT,ISEASN,ISORCE) = AC(IPOLUT,ISEASN) * (CS(IPOLUT,ISEASN,
     1   ISORCE) / CPOLUT(IPOLUT,ISEASN,IRECEP)) + BC(IPOLUT,ISEASN) *
     2   CS(IPOLUT,ISEASN,ISORCE)
      CPOLUT(IPOLUT,ISEASN,IRECEP) = AC(IPOLUT,ISEASN) + BC(IPOLUT,
     1   ISEASN) * CPOLUT(IPOLUT,ISEASN,IRECEP)
  520 CONTINUE
      DO 530 ISORCE=1,NSORCE
C
C     WRITE DATA RECORD
      WRITE(12) JSIC(ISORCE),JSITE(ISORCE),((CS(IPOLUT,ISEASN,ISORCE),
     1             IPOLUT=IPOLU1,IPOLU2,ISKIPP),ISEASN=3,3)
C
  530 CONTINUE
      WRITE (6,8800) IRECEP,RECEPT(1,IRECEP),RECEPT(2,IRECEP),
     1 (( PTCON(IPOLUT,ISEASN,IRECEP),IPOLUT=IPOLU1,IPOLU2,ISKIPP),
     2                           ISEASN=ITIME1,ITIME2,ISKIPT)
      WRITE (6,8800) IRECEP,RECEPT(1,IRECEP),RECEPT(2,IRECEP),
     1 ((CPOLUT(IPOLUT,ISEASN,IRECEP),IPOLUT=IPOLU1,IPOLU2,ISKIPP),
     2                           ISEASN=ITIME1,ITIME2,ISKIPT)
 8800 FORMAT (I5,2F8.2,9E12.5)                                          DIFMOD2
C     RECEPTOR CONCENTRATIONS FOR EACH POLLUTANT,                       DIFMOD2
C                             FOR EACH SEASON                           DIFMOD2
C              IS NOW COMPLETE FOR THIS RECEPTOR.                       DIFMOD2
C                                                                       DIFMOD2
C                                                                       DIFMOD2
C     TEST FOR ZMIN/ZMAX USING CPOLUT                                   DIFMOD2
      DO 820 ISEASN=ITIME1,ITIME2,ISKIPT                                DIFMOD2
      DO 820 IPOLUT=IPOLU1,IPOLU2,ISKIPP
      IF(ZMIN(IPOLUT,ISEASN) .GE. CPOLUT(IPOLUT,ISEASN,IRECEP))         DIFMOD2
     1   ZMIN(IPOLUT,ISEASN)   =  CPOLUT(IPOLUT,ISEASN,IRECEP)          DIFMOD2
      IF(ZMAX(IPOLUT,ISEASN) .LE. CPOLUT(IPOLUT,ISEASN,IRECEP))         DIFMOD2
      C3=C2                                                             DIFMOD2
      GO TO 5000
  240 XD=X1                                                             DIFMOD2
      GO TO 320                                                         DIFMOD2
  310 XD=X                                                              DIFMOD2
  320 C1=0.                                                             DIFMOD2
      ZEKE=-.5*PHT*PHT/(SIGZ*SIGZ)
      IF (ZEKE.LE.-70.) GC TO 325
      C1= (.0203*Y)/(SIGZ*XD)*(EXP(ZEKE))
  325 IF (.NOT. SGTDMX) GC TO 330
      C3=C1                                                             DIFMOD2
      GO TO 5000
  330 C3=C1-((X-X1)/X1)*(C1-C2)                                         DIFMOD2
C
 5000 CONTINUE
      DO 500 IPOLUT=IPCLU1,IPOLU2,ISKIPP
      SC=C3*SINTEN(IPCLUT,ISEASN,ISORCE)
      IF (IPOLUT.EQ.1) SC=SC*ALIFE
      CS(IPOLUT,ISEASN,ISORCE)=CS(IPOLUT,ISEASN,ISORCE)+SC
      IF (IPOINT.NE.1) GO TO 402
      PTCON(IPOLUT,ISEASN,IRECEP)=PTCCN(IPOLUT,ISEASN,IRECEP)+SC
  402 CPOLUT(IPOLUT,ISEASN,IRECEP)=CPOLUT(IPOLUT,ISEASN,IRECEP)+SC
  500 CONTINUE
C     END OF LOOP ON PCLLUTANTS
C                                                                       DIFMOD2
  600 CONTINUE                                                          DIFMOD2
C                                                                       DIFMOD2
C     END OF LOOP ON SEASCN                                      ISEASN DIFMOD2
C                                                                       DIFMOD2
  700 CONTINUE                                                          DIFMOD2
C                                                                       DIFMOD2
C     END OF LOOP ON WIND DIRECTION                              IWNDIR DIFMOD2
C                                                                       DIFMOD2
  800 CONTINUE                                                          DIFMOD2
C                                                                       DIFMOD2
C     END OF LOOP ON SCURCE                                      ISORCE DIFMOD2
C                                                                       DIFMOD2
```

```
      X=2.*DNWIND                                                       DIFMOD2
      IF(CXWIND-(SRAD+X*PI8))150,150,700                                DIFMOD2
  130 Q=QSCALE*(PI4*(X*X-4.08*X*SDIAM+4.1616*SDIAM*SDIAM))/(SRAD*SRAD*  DIFMOD2
     1                                                           16.)   DIFMOD2
C     FROM Q=QSCALE*(.1965*(X-2.040*SDIAM)**2.)/SDIAM**2.               DIFMOD2
      DNWIND=SINWD(3)*(DNWIND+SRAD)                                     DIFMOD2
C     WHERE SINWD(3) = SIN(PI8*2) OR SIN(PI/4) OR .70711                DIFMOD2
      X=DNWIND*2.                                                       DIFMOD2
      IF(CXWIND-SRAD)150,150,700                                        DIFMOD2
  140 Q=QSCALE                                                          DIFMOD2
  150 IF(DNWIND .GE. 1000.) GO TO 160                                   DIFMOD2
      IF(DNWIND .LT. 100.) DNWIND=100.                                  DIFMOD2
      L=2                                                               DIFMOD2
  160 SIGZ=A(L)*DNWIND**B(L)+C(L)                                       DIFMOD2
      Q=Q*(Y-CXWIND)/Y                                                  DIFMOD2
C     LOOP ON SEASON                                             ISEASN DIFMOD2
C                                                                       DIFMOD2
      DO  600 ISEASN=ITIME1,ITIME2,ISKIPT                               DIFMOD2
      U=UW(IWNDIR,ISEASN)
      IF (TS(ISORCE)) 180,180,170
  170 PHT=HS(ISORCE)+VS(ISORCE)*DS(ISORCE)*(1.5+.00268*PA*DS(ISORCE)*
     1     (TS(ISORCE)-TA)/TS(ISORCE))/U
  180 ALIFE=EXP(-.693*(DNWIND/U)/10800.)
      DMIX=DPTHMX(ISEASN)                                               DIFMOD2
C     NOTE -- Y IS SET TO THE PRODUCT OF Q, ARG2,  AND FOVU OF VER 1    DIFMOD2*
      Y=Q*WDFREQ(IWNDIR,ISEASN)                                         DIFMOD2*
      SGTDMX=.TRUE.                                                     DIFMOD2
      IF(SIGZ .LE. (0.47*DMIX)) GO TO 310                               DIFMOD2
      X1=EXP(ALOG((0.47*DMIX-C(1))/A(1))/B(1))                          DIFMOD2*
      IF(X1 .LT. 1000.) X1=EXP(ALOG((0.47*DMIX-C(2))/A(2))/B(2))        DIFMOD2*
      IF(X-2.*X1)220,210,210                                            DIFMOD2
  210 XD=X                                                              DIFMOD2
      GO TO 230                                                         DIFMOD2
  220 XD=2.0*X1                                                         DIFMOD2
      SGTDMX=.FALSE.                                                    DIFMOD2
  230 C2=(0.0255*Y)/(DMIX*XD)                                           DIFMOD2*
      IF(.NOT. SGTDMX) GO TO 240                                        DIFMOD2
      PTCON(IPOLUT,ISEASN,IRECEP)=0.0
 9999 CPOLUT(IPOLUT,ISEASN,IRECEP)=C.C
C
C     WRITE RECEPTOR LCCATICNS
      WRITE(12) (RECEPT(L,IFECEP),L=1,2),IRECEP
C
C     LOOP ON SOURCE                                              ISORCE DIFMOD2
      DO  800 ISORCE=1,NSCRCE                                            DIFMOD2
      SDIAM=SOURCE(3,ISCRCE)                                             DIFMOD2
C
C     SET UP FLAG FO PCINT SOURCE
      IPOINT=0
      IF (SDIAM.LE.10C) IPOINT=1
C
      SRAD=SDIAM/2.                                                      DIFMOD2
C     LOOP ON WIND DIRECTION                                      IWNDIR DIFMOD2
      DO  700 IWNDIR=1,16                                                DIFMOD2
C                                                                        DIFMOD2
      L=1                                                                DIFMOD2
      DNWIND=GDSCAL*((SCURCE(2,ISORCE)-RECEPT(2,IRECEP))*COSWD(IWNDIR)+ DIFMOD2
     1                 (SCURCE(1,ISORCE)-RECEPT(1,IRECEP))*SINWD(IWNDIR)) DIFMOD2
      X=DNWIND+SDIAM/PI8                                                 DIFMOD2
      IF(SDIAM .GT. 1CC.) GO TO 110                                      DIFMOD2
      IF(X) 700, 700,1CC
  10C PHT=HS(ISORCE)
      GO TO 120
  11C IF(SRAD+DNWIND)7CC,7CC,115
  115 PHT=0.0
  120 CXWIND=GDSCAL*ABS((SCURCE(2,ISORCE)-RECEPT(2,IRECEP))*            DIFMOD2
     1SINWD(IWNDIR)-(SCURCE(1,ISORCE)-RECEPT(1,IRECEP))*COSWD(IWNDIR))  DIFMOD2
      Y=X*PI8                                                            DIFMOD2
      IF(Y .LE. CXWINC) GC TC 70C                                        DIFMOD2
      IF( SRAD     .GT. ABS(DNWIND)) GO TO 130                           DIFMOD2
      IF(SDIAM  .LE. (DNWIND*PI8)) GO TO 140                             DIFMOD2
      Q=QSCALE*((PI8*X-SDIAM)/SDIAM)                                     DIFMOD2
      DNWIND=SQRT((DNWIND*DNWIND)+(SRAD*SRAD))                           DIFMOD2
C     FROM DNWIND=((4.*DNWIND**2.+SDIAM**2.)**.5)/2.   (DISTANCE TERM ?)DIFMOD2
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      SUBROUTINE POLUT
C     *******************SPECIFICATION STATEMENTS*************************DIFMOD2
      LOGICAL SGTDMX                                                    DIFMOD2
C                 FCR SIGZ GREATER THAN DMIX -- A LCGICAL VARIABLE     DIFMOD2
      LOGICAL PNCH/.TRUE./                                              DIFMOD2
C                 FCR PUNCH - CR NCT PUNCH 1130 CECK                    DIFMOD2
      LOGICAL REPLAY/.FALSE./                                           DIFMOD2
C              ALLOW WRITING TO CONVERTED DATA                          DIFMOD2
C
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              ACSTAN(2,3,3),PERCNT(3)
      COMMON /CONS/ PI4,PI8,NCCLPG,NLEFT,NRIGHT
      COMMON /CORD/ CCNVER(2),ORIGIN(2),RBASE(2),DELTA,SMTOSK,FTTOKM,
     1              GDSCAL,UNITS,INCRX,INCRY,DEGREE,STAKE,UTM,QSCALE
      COMMON /DOL/ IPCLU1,IFOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /LITL/ ABBREV(6),PEGION(18),APOIN(4,2),PNAME(6,3),
     1               PUNITS(5,3),SNAME(2,3),UNTS
      COMMON /LOGI/ SGTCMX,PNCH,REPLAY
      COMMON /MAX/  MXRECP,MXPOL,MXSESN,MXINTV
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),OPCLUT(3,3,20),
     1             PTCCN(3,3,237),NRECEP ,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /REST/ A(2),B(2),C(2),ZMIN(3,3),ZMAX(3,3),POLCON(3),LINES
      COMMON /RGSN/ AC(3,3),BC(3,3),CCRREL(25)
      COMMON /SELCT/ ISEL12(3,3,12),NSEL12,ISEL5(3,3,5),NSEL5,SELC12
     1              (3,3,12)
      COMMON /SRCE/ SCURCE(3,2CC),SINTEN(3,3,237),NSCRCE,CS(3,3,200)
     1               ,IFLAG,JSIC(20C),JSITE(200)
      COMMON /STAK/ HS(2CO),VS(200),DS(200),TS(200),PA,TA
      COMMON /WIND/ WDFREQ(16,3),SINWD(16),COSWD(16),DPTHMX(3),UW(16,3)
   95 CONTINUE
      DO 9999 ISEASN=ITIME1,ITIME2,ISKIPT
      DO 9999 IPOLUT=IPCLU1,IPOLU2,ISKIPP
      DO 9998 ISORCE=1,NSCRCE
      CS(IPOLUT,ISEASN,ISCRCE)=C.0
 9998 CONTINUE
```

A.2 CONTROL COST-EFFECTIVENESS MODEL

```
      SUBROUTINE CCST                                                   COST  10
C                                                                       COST  20
C     COST EFFECTIVENESS ROUTINE                                        COST  30
C         FCR REGICNAL AIR POLLUTION ANALYSIS STUDY                     COST  40
C                                                                       COST  50
      INTEGER PRCUN                                                     COST  60
      DIMENSION PFAC (3,3,2)                                            COST  70
      DIMENSICN CHARC(125)                                              COST  80
      DIMENSICN ISAVE(5)                                                COST  90
      DIMENSICN CLHR(3),OFHC(4,3),OFCOST(4,3),DEVEFF(3),DCOC(3)COST 100
     2    ,FLHR(3),PEFF(3)                                              COST 110
      DIMENSICN CFSC(4,3),DUV(3),PRCRT(3,4,3),PRCPJ(3)                  COST 120
     2    ,EMFAC(3,4),EMRAT(3,3)                                        COST 130
      DIMENSICN FCL(3),XOM(3),OFT(3),OFBTU(3)                           COST 140
     2    ,BTLWT(3),EFF(3),HEO(3),OFC(3),BTUYR(3)                       COST 150
      DIMENSICN CFSC1(3),PR(3),CFHC1(3)                                 COST 160
      DIMENSICN EI(3),OFQ(3),RR(3),BEFF(3,2),IFT(8)                     COST 170
      DIMENSICN CER(3)                                                  COST 180
      DIMENSICN EFFN(3),EMN(3)                                          COST 190
      DOUBLE PRECISICN ERROR(10)                                        COST 200
      EQUIVALENCE (SPRIME,CINCST)                                       COST 210
      EQUIVALENCE (FUELCR,FUELS),(POL(1),DCCC(1))                       COST 220
      DATA MODE/1/                                                      COST 230
      DATA EFRCR /'PR/OFHC ','AFHC    ','EMRAT-S ','OPER.HR.'           COST 240
     2           ,'CFC/PR  ','AFC     '/                                COST 250
      DATA FBLK /'        '/                                            COST 260
      DATA BEFF  /.87,.86,.82,.75,.77,.80/                              COST 270
      DATA PFAC /0.C,C.0,0.0,0.5,0.04,0.,112.,10.,15.,                  COST 280
     2           0.C,0.0,0.0,3.0,2.0,0.4, 91.,18.,18. /                 COST 290
      DATA IC/9/,JREC/1/,IS/8/,KREC/1/,LTYPE/3/,IP/6/,IN/5/             COST 300
      DATA CHARF/'F'/, CHARI/'I'/, LTYPE /3/                            COST 310
      DATA CCCL/'C'/,CCIL/'O'/,CGAS/'G'/,CBLK/' '/                      COST 320
      DATA AFSC/C./,CLHR/3*0./,SALETX,TAXCR,RATE/3*0./                  COST 330
     2    ,XCHRS/8760./,TEMP/0./,OFHC/12*0./,OFCOST/12*0./              COST 340
     3    ,STKHTM,ELCS/2*0./,DEVEFF/3*0./,XMP1,XMP2,XMP3/3*0./COST 350
     4    ,ERCOST,ARCFEE,AUXEQ,UTIL,STCOST,SPCOST,RECOST                COST 360
     5    ,TRKOST,CINCST,FLF,PRDROP,FLIQQ,FLIQS/13*0./                  COST 370
     6         ,FCL/3*0./,ELCQ,FUELS,FUELQ/3*0./,FLHR/3*0./                COST 380
     7         ,AFC,AFHC,CAP,PAC /4*0./,PEFF/3*0./                         COST 390
     8         ,TEXN,CATLST,CATS,EXFSC/4*0./                               COST 400
          DATA XLOCN,YLOCN,AREA,XLINE,YLINE/5*0./,OFSC/12*0./              COST 410
     2         ,STKHT,STKDIA,EXVEL,EXITTM,EXPRES /5*0./,DUV/3*3./          COST 420
     3         ,ICDE/0/,CONEFF/0./,PRCRT/36*0./,PRCPJ/3*0./                COST 430
     4         ,EMFAC/12*0./,EMRAT/9*0./                                   COST 440
          DATA DEPR,ACC,AC /3*0./                                          COST 450
          DATA ITEND /9999/,BLK/' '/,ZE/0.0/,IZE/0/                        COST 460
          DEFINE FILE 8(1000,500,E,KREZ),9(1000,500,E,JREZ)                COST 470
          DEFINE FILE 13(1999,500,E,IND3), 14(1999,500,E,IND4)             COST 480
          NAMELIST /CINPUT/ JSIC,JSITE,ICD,AFSC,CLHR,                      COST 490
     2      SALETX,TAXCR,RATE,XOHRS,TEMP,OFHC,OFCOST,STKHTM,ELCS,          COST 500
     3      DEVEFF,XMP1,XMP2,XMP3,ERCOST,ARCFEE,AUXEQ,UTIL,STCOST,         COST 510
     4      SPCOST,RECOST,TRKOST,CINCST,FLF,PRDRCP,FLIQQ,FLIQS,            COST 520
     5      POL,ELCC,FUELS,FUELQ,FLHR,AFC,AFHC,CAP,PAC,PEFF,               COST 530
     6      TEXN,CATLST,CATS,EXFSC                                         COST 540
          NAMELIST /EINPUT/ KSIC,KSITE,KFLAG,XLOCN,YLOCN,AREA,             COST 550
     2      XLINE,YLINE,OWNERS,OFSC,PRCUN,PRTYPE,STKHT,STKDIA,             COST 560
     3      EXVEL,EXITTM,EXPRES,DUV,ICDE,CONEFF,PRCRT,PRCPJ,               COST 570
     4      EMFAC,EMRAT                                                    COST 580
          WRITE (6,895)                                                    COST 590
          JFLG=0                                                           COST 600
          IN13=1                                                           COST 610
          IN14=1                                                           COST 620
          ICARD=0                                                          COST 630
          JSOR=99999999                                                    COST 640
 1000     CONTINUE                                                         COST 650
          JSICP=0                                                          COST 660
          IF (ICARD.EQ.0) GO TO 1020                                       COST 670
          INX2=IN14-1                                                      COST 680
          IF (ITYPE.NE.2) GO TO 1010                                       COST 690
          INX1=INS1                                                        COST 700
          INX2=INS2                                                        COST 710
          NSOUR=NSOURS                                                     COST 720
 1010     CONTINUE                                                         COST 730
          WRITE (13'IN13,1025) ITYPE,IASTRG,ASULCN,ACORD,ACABS             COST 740
     .        ,ASLOP,ACABB,NSOUR,INX1,INX2
               IN13=IN13+1
 1020          CONTINLE
               ICARD=1
               INS1=INX1
               INS2=INX2
               NSCURS=NSCUR
               INX1=IN14
C
C              READ CCST MODEL INPUT CARD
C
               READ (IN,1C15,END=9000) ISIC,ISITE1,ISITE2,ITYPE,IASTRG,
     .              ASULCN,IAFUEL,ACORD,ACABS,ASLCP,ACABB ,IDUMP
               ISCR=1CCCC*ISIC+ISITE1
               IF (ISCR.GT.JSOR) GO TC 1100
               JREC=1
               KREC=1
 1100          CONTINUE
               NSOUR=C
C              IF 'SIC' NC. IS PRESENT, PROCESS THIS GROUP ONLY
C                   SITES ISITE1 THROUGH ISITE2
               IF (ISIC.NE.C) GC TO 1400
C              ITYPE USEC IF SIC IS BLANK
C                   =0,  CC ALL SOURCES
C                   =1,  CC CCMBLSTION SOURCES ONLY
C                   =2,  USE PREVIOUS SOURCES FOR NEW STRATEGY
               IF (ITYPE.EQ.C) GC TC 1200
               IF (ITYPE.EQ.1) GO TO 1300
C
C              WRITE CCNTRCL RECCRD
C
               GC TO 1CCO
 1200          CCNTINLE
C              IRTRN=3 - CO ALL SOURCES
               IRTRN=3
               GO TO 15CO
 1300          CONTINLE
```

```
C     IPTRN=2 - CC CCMBUSTION SCURCES ONLY
      IRTRN=2
      GC TO 15CC
 1400 CONTINLE
C     IRTRN=1 - PRCCESS SPECIFIED SIC GROUP CNLY
      IRTRN=1
      I=ISITE1
      IFLG=0
 1500 CONTINUE
C
C     READ CCST-EFFECTIVENESS RECORD, CHECK FCR EOF
C
      READ (IC'JREC,991) JSIC,JSITE,ICD,AFSC,(CLHR(K),K=1,3)
     2      ,SALETX,TAXCR,RATE,XCHRS,TEMP,((OFHC(L,M),
     3       M=1,3),L=1,2),OFHC(3,1),((OFCCST(L,M),M=1,3),
     4 L=1,2),OFCOST(3,1),   STKHTM,ELCS,(DEVEFF(L),L=1,3)
     5      ,XMP1,XMP2,XMP3,ERCOST,ARCFEE,AUXEC,UTIL,STCOST
     6      ,SPCCST,RECOST,TRKCST,CINCST,FLF,PRDROP,FLIQQ,FLIQS
     7      ,(PCL(L),L=1,3),ELCQ,FUELS,FUELC,(FLHR(L),L=1,3)
     8      ,AFC,AFHC,CAP,PAC,(PEFF(L),L=1,3),TEXN,CATLST
     9      ,CATS,EXFSC
      JREC=JREC+1
      IF ((JSIC.EQ.9999).AND.(JSITE.EQ.9999)) GO TO 1C0C
      IF (POL(3).EC.0.C) POL(3)=1.0
      IF (IRTRN.EQ.3) GC TO 1900
      IF (IRTRN.EQ.2) GC TO 1900
C     MATCH CE SIC NO. WITH SPECIFIED SIC NC.
      IF (JSIC -  ISIC) 1500,17C0,1580
 1580 CONTINLE
C     ERROR
      WRITE (IP,1585) ISIC
 1585 FORMAT ( ' ** NC CGST DATA FOR SIC',I5 )
      GO TO 1CC0
 1700 CONTINLE
      IF (JSITE-I) 20CC,1800,1720
 1720 CONTINLE
C     IFLG=0 INDICATES CARD, CE, AND EM HAVE NOT MATCHED YET
```

```
C             IFLG=1 INDICATES SIC AND SITE AGREEMENT BETWEEN FILES
              IF (JSIC.NE.ISIC) GO TC 1760
              I=JSITE
              IF (I.LE.ISITE2) GO TO 19C0
 1760         CONTINUE
              IF (IFLG.EC.1) GO TC 2200
 1780         CCNTINLE
C             ERROR
              WRITE (IP,1785) ISIC,ISITE1,ISITE2
 1785         FORMAT ('1 **     SIC ',I4,' HAS NO CCST DATA FOR',
     2             ' SITES ',I4,'-',I4)
              GO TC 1CC0
 1800         CONTINLE
              IFLG=1
 1900         CONTINLE
              GC TO 23C0
 2000         CONTINLE
 2100         CONTINUE
C
C             READ CCST-EFFECTIVENESS RECCRD
C
              READ (IC'JREC,991) JSIC,JSITE,ICD,AFSC,(CLHR(K),K=1,3)
     2             ,SALETX,TAXCR,RATE,XCHRS,TEMP,((CFHC(L,M),
     3              M=1,3),L=1,2),OFHC(3,1),((OFCCST(L,M),M=1,3),
     4 L=1,2),OFCCST(3,1),    STKHTM,ELCS,(DEVEFF(L),L=1,3)
     5             ,XMP1,XMP2,XMP3,ERCOST,ARCFEE,AUXEC,UTIL,STCOST
     6             ,SPCCST,RECOST,TRKOST,CINCST,FLF,PRCROP,FLIQQ,FLIQS
     7             ,(FCL(L),L=1,3),ELCQ,FUELS,FUELC,(FLHR(L),L=1,3)
     8             ,AFC,AFHC,CAP,PAC,(PEFF(L),L=1,3),TEXN,CATLST
     9             ,CATS,EXFSC
              JREC=JREC+1
              IF ((JSIC.EQ.9999).AND.(JSITE.EC.9999)) GO TO 100C
              IF (POL(3).EC.0.C) POL(3)=1.0
              GC TO 17CC
 220C         CONTINUE
C             MODE ...
              IF ((MCDE.EQ.1).CR.(MODE.EQ.3)) GC TC 1000
```

```
C                                                                       COST1860
C             WRITE CCNTRCL RECCRD                                      COST1870
C                                                                       COST1880
              ISAVE(1)=ISIC                                             COST1890
              ISAVE(2)=ISITE1                                           COST1900
              ISAVE(3)=ISITE2                                           COST1910
              ISAVE(4)=ICNT                                             COST1920
              ISAVE(5)=ITYPE                                            COST1930
              GO TO 1000                                                COST1940
 2300         CONTINUE                                                  COST1950
              JSCR=1CCCO*JSIC+JSITE                                     COST1960
              ACC=0.                                                    COST1970
              AC=0.                                                     COST1980
              IF (FLF.LT.1.) FLF=1.                                     COST1990
              DEPR=1./FLF                                               COST2000
C             UNIT CCNVERSIONS (CCNTROL DEVICE COST CATA)               COST2010
              AFSC=AFSC    *1.E-2                                       COST2020
              SALETX=SALETX*1.E-2                                       COST2030
              TAXCR=TAXCR  *1.E-2                                       COST2040
              RATE=RATE    *1.E-2                                       COST2050
              ERCOST=ERCCST*1.E-2                                       COST2060
              ARCFEE=ARCFEE*1.E-2                                       COST2070
              AUXEQ=ALXEC  *1.E-2                                       COST2080
              UTIL=UTIL    *1.E-2                                       COST2090
              STCOST=STCCST*1.E-2                                       COST2100
              SPCOST=SPCCST*1.E-2                                       COST2110
              RECOST=RECCST*1.E-2                                       COST2120
              TRKOST=TRKCST*1.E-2                                       COST2130
              CINCST=CINCST*1.E-2                                       COST2140
              FLIQS=FLICS*1.E-3                                         COST2150
              DO 2310 L=1,3                                             COST2160
              DO 231C M=1,3                                             COST2170
 2310         OFHC(L,M)=OFHC(L,M)*1.E+6                                 COST2180
              ELCS=ELCS*1.E-1                                           COST2190
              AFHC=AFHC*1.E+6                                           COST2200
              IF ((JSITE.EQ.JSITEP).AND.(JSIC.EQ.JSICP)) GO TO 2640     COST2210
 2380         CONTINUE                                                  COST2220
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C                                                                       COST2230
C             READ EMISSION INVENTORY RECORD                            COST2240
C                                                                       COST2250
              READ (IS'KREC,995) KSIC,KSITE,KFLAG,XLOCN,YLOCN,AREA      COST2260
     2       ,XLINE,YLINE,OWNERS,((OFSC(L,M),M=1,3),L=1,2),OFSC(3,1)    COST2270
     3            ,OFSC(4,1),PRCUN,PRTYPE,PRTYPN,STKHT,STKDIA,EXVEL     COST2280
     4            ,EXITTM,EXPRES,(DUV(K),K=1,3),ICDE,CONEFF             COST2290
     5            ,((((PRCRT(K,L,M),M=1,3),L=1,2),PRCRT(K,3,1),         COST2300
     6                  PRCRT(K,4,1)),K=1,3), (PRCPJ(K),K=1,3)          COST2310
     7            ,((EMFAC(J,L),L=1,4),J=1,3)                           COST2320
     8            ,((EMRAT(K,J),J=1,3),K=1,3)                           COST2330
              KREC=KREC+1                                               COST2340
              IF ((KSIC.EQ.9999).AND.(KSITE.EQ.9999)) GO TO 1000        COST2350
C             MATCH EM SIC AND SITE WITH CE                             COST2360
              IF (KSIC-JSIC) 2380,2400,2480                             COST2370
 2400         CONTINUE                                                  COST2380
              IF (KSITE-JSITE) 2380,2500,2480                           COST2390
 2480         CONTINUE                                                  COST2400
C             ERROR                                                     COST2410
              WRITE (IP,2485) JSIC,JSITE                                COST2420
 2485         FORMAT (  '  ** ERROR **  SIC',I5,' OR SITE',I5,          COST2430
     .            ' NOT FOUND IN SOURCE EMISSION FILE'  )               COST2440
              KREC=MAX0(1,KREC-2)                                       COST2450
              IF (IRTRN.EQ.1) GO TO 2100                                COST2460
              GO TO 1500                                                COST2470
C                                                                       COST2480
 2500         CONTINUE                                                  COST2490
              IF (IRTRN.NE.2) GO TO 2504                                COST2500
              IF((PRTYPE.EQ.CHARF ).OR.(PRTYPE.EQ.[illegible])) GO TO 2504  COST2510
              GO TO 1500                                                COST2520
 2504         CONTINUE                                                  COST2530
              NSOUR=NSOUR+1                                             COST2540
              DO 2510 L=1,4                                             COST2550
              DO 2510 M=1,3                                             COST2560
 2510         OFSC(L,M)=OFSC(L,M)*1.E-2                                 COST2570
              DO 2520 L=1,3                                             COST2580
 2520         PRCPJ(L)=PRCPJ(L)*1.E-2                                   COST2590
 2600     CCNTINLE                                                       COST2600
          JSITEP=JSITE                                                   COST2610
          JSICP=JSIC                                                     COST2620
          WRITE (IP,4515)                                                COST2630
          WRITE (IP,4535)JSIC,JSITE,(EMRAT(3,K),K=1,3)                   COST2640
 2640     CONTINLE                                                       COST2650
          IF (IRTRN.NE.2) GC TO 266C                                     COST2660
C         IF SOUKCE IS CGMBLSTICN, PROCESS                               COST2670
          IF((PRTYPE.EQ.CHARF ).CR.(PRTYPE.EQ.CHARI )) GO TO 2660        COST2680
          GO TO 15CC                                                     COST2690
 2660     CCNTINUE                                                       COST2700
          SBTU=0.                                                        COST2710
          DO 272C L=1,3                                                  COST2720
          OFSC1(L)=C.                                                    COST2730
          OFHC1(L)=OFHC(L,1)                                             COST2740
          XN=0.                                                          COST2750
          PR(L)=C.                                                       COST2760
          DC 271C M=1,3                                                  COST2770
          P1=PR(L)                                                       COST2780
          PR(L)=PR(L)+PRCRT(3,L,M)                                       COST2790
          P1=PR(L)-P1                                                    COST2800
          IF (P1        .EQ.0) GO TO 2710                                COST2810
          XN=XN+1                                                        COST2820
          OFSC1(L)=OFSC1(L)+OFSC(L,M)                                    COST2830
 2710     CCNTINUE                                                       COST2840
          OFC(L)=OFCCST(L,1)                                             COST2850
          IF (OFSC1(L).EG.C.0) GC TO 2720                                COST2860
          OFSC1(L)=OFSC1(L)/XN                                           COST2870
 2720     CONTINLE                                                       COST2880
          DO 282C K=1,3                                                  COST2890
          EI(K)=EMRAT(3,K)*CEVEFF(K)/100.                                COST2900
          OFQ(K)=PR(K)        /24.*XOHRS                                 COST2910
 2820     CONTINLE                                                       COST2920
C         COMPUTE BTL/CAY FCR ORIGINAL FUEL TYPE                         COST2930
          SOFBTU=0.                                                      COST2940
          DO 281C M=1,3                                                  COST2950
          OFBTU(M)=PR(M)*OFHC1(M)                                        COST2960
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              SCFBTU=SOFBTL+OFBTU(M)                                   COST2970
 2810         CONTINUE                                                 COST2980
              DC 284C MP=1,3                                           COST2990
              RR(MP)=C.                                                COST3000
              DO 284C MF=1,3                                           COST3010
              RR(MP)=RR(MP)+.39*OFBTU(MF)*OFQ(MF)                      COST3020
 2840         CONTINUE                                                 COST3030
              XXX=CAF                                                  COST3040
              IF (ICC.EQ.45) XXX=EMRAT(3,1)*DEVEFF(1)/200.             COST3050
              IF (ICC.EQ.48) XXX=STKHTM                                COST3060
              IF (ICD.EQ.39) XXX=0.                                    COST3070
              FFF=RR(1)/(3415.*8760.)                                  COST3080
              IF ((ICD.GE.40).AND.(ICD.LE.42)) XXX=FFF                 COST3090
              IF ((ICD.GE.23).AND.(ICD.LE.26)) XXX=FFF                 COST3100
              IF (ICD.EQ.49) XXX=ALOG10(PRCRT(3,4,1)*1.E+3)            COST3110
C             DETERMINE MANUFACTURERS LIST PRICE                       COST3120
              H=XMP1+XXX*(XMP2+XMP3*XXX)                               COST3130
              IF (ICD.EQ.49) H=10.0**H                                 COST3140
C             APPLY CCRRCSIVE FACTOR IF REQUIRED                       COST3150
              IF (JSIC.NE.2819) GO TO 2700                             COST3160
              H=5.*H                                                   COST3170
              IF (TEMP.LT.135.C) H=.34*H                               COST3180
 2700         CONTINUE                                                 COST3190
              MFLG=0                                                   COST3200
C             CHECK FCR FUEL SUBSTITUTION                              COST3210
              IF ((ICD.GE.27).AND.(ICD.LE.37)) GO TC 5000              COST3220
              MFLG=1                                                   COST3230
              IF (SOFBTU.GT.1.E-10) GO TC 5000                         COST3240
 2800         CONTINUE                                                 COST3250
C             COMPUTE ACCITIONAL INITIAL COSTS                         COST3260
              IF (SPRIME.EQ.0)                                         COST3270
     .        SPRIME=SALETX+TAXCR+TRKOST+ERCOST+ARCFEE+AUXEQ+UTIL      COST3280
     .              +STCOST+SPCOST+RECOST                              COST3290
C             COMPUTE TOTAL INITIAL CUTLAY                             COST3300
              COSTIN=H+SPRIME*H                                        COST3310
C             CCMPUTE ANNUAL CHARGE PERCENTAGE AND ANNUAL CAPITAL      COST3320
C                   CCST IF NOT ALREADY COMPUTED                       COST3330
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      IF (ACC.NE.0.0) GO TO 3000                                        COST3340
      IF (AC .NE.0.0) GO TO 2900                                        COST3350
C     COMPUTE ANNUAL CAPITAL CHARGE AND ANNUAL % CHARGE                 COST3360
C          IF NOT INPUT                                                 COST3370
      AC=DEPR+RATE                                                      COST3380
 2900 CONTINUE                                                          COST3390
      ACC=AC*CCSTIN                                                     COST3400
      GO TO 3100                                                        COST3410
 3000 CONTINUE                                                          COST3420
 3100 CONTINUE                                                          COST3430
      SHRS=0.0                                                          COST3440
C     COMPUTE LABOR COSTS                                               COST3450
      DO 3200 M=1,LTYPE                                                 COST3460
      SHRS=SHRS+FLHR(M)*CLHR(M)                                         COST3470
 3200 CONTINUE                                                          COST3480
C                                                                       COST3490
 3500 CONTINUE                                                          COST3500
      ACC=ACC*1.E+3                                                     COST3510
      TAC=ACC                                                           COST3520
      DO 3560 K=1,3                                                     COST3530
 3560 XOM(K)=0.                                                         COST3540
C                                                                       COST3550
C     COMPUTE OPERATING AND MAINTENANCE COST FOR CONTROL                COST3560
C         DEVICE AND EACH POLLUTANT                                     COST3570
C                                                                       COST3580
      IF ((ICD.GE. 1).AND.(ICD.LE. 3)) GO TO 3610                       COST3590
      IF ((ICD.GE. 4).AND.(ICD.LE. 9)) GO TO 3620                       COST3600
      IF ((ICD.GE.10).AND.(ICD.LE.15)) GO TO 3630                       COST3610
      IF ((ICD.GE.16).AND.(ICD.LE.18)) GO TO 3640                       COST3620
      IF ((ICD.GE.19).AND.(ICD.LE.22)) GO TO 3650                       COST3630
      IF ((ICD.GE.23).AND.(ICD.LE.24)) GO TO 3660                       COST3640
      IF  (ICD.EQ.49) GO TO 3650                                        COST3650
      IF  (ICD.EQ.40) GO TO 3670                                        COST3660
      IF  (ICD.EQ.41) GO TO 3680                                        COST3670
      IF  (ICD.EQ.42) GO TO 3690                                        COST3680
      IF  (ICD.EQ.25) GO TO 3710                                        COST3690
      IF  (ICD.EQ.26) GO TO 3720                                        COST3700
      IF  (ICC.EC.38) GC TO 3730                                        COST3710
      IF  (ICC.EC.45) GC TO 374C                                        COST3720
      IF  (ICD.EC.48) GC TO 375C                                        COST3730
      IF  (ICC.EC.47) GO TO 376C                                        COST3740
C     THE REMAINING RAPA CODES ...                                      COST3750
      GC TO 43C0                                                        COST3760
C     WET COLLECTORS                                                    COST3770
 3610 DC 3618 K=1,3                                                     COST3780
      XOM(K)=XCHRS*(ELCC*ELCS+FLIQQ*FLIQS                               COST3790
     .  +(EI(K)  *3. *PCL(K))/24.)+SHRS                                 COST3800
 3618 CONTINLE                                                          COST3810
      GO TO 4300                                                        COST3820
C     MECHANICAL CCLLECTORS                                             COST3830
 3620 DO 3628 K=1,3                                                     COST3840
      XOM(K)=XCHRS*(ELCC*ELCS+(EI(K)   *3.    *POL(K)/24.))             COST3850
     .  +SHRS                                                           COST3860
 3628 CONTINLE                                                          COST3870
      GO TO 4300                                                        COST3880
C     ELECTRCSTATIC PRECIPITATORS                                       COST3890
 3630 CONTINLE                                                          COST3900
      DC 3638 K=1,3                                                     COST3910
      XOM(K)=XOHRS*(ELCC*ELCS+(EI(K)   *3.    *POL(K)/24.))             COST3920
     .  +SHRS                                                           COST3930
 3638 CONTINUE                                                          COST3940
      GC TO 4300                                                        COST3950
C     FABRIC FILTERS                                                    COST3960
 3640 CONTINUE                                                          COST3970
      DO 3648 K=1,3                                                     COST3980
      XUM(K)=XOHRS*(ELCQ*ELCS+(EI(K)   *3.    *POL(K)/24.))             COST3990
     .  +SHRS                                                           COST4000
 3648 CONTINLE                                                          COST4010
      GC TO 43C0                                                        COST4020
C     INCREASED CCMBUSTION EFFICIENCY                                   COST4030
 3650 CONTINUE                                                          COST4040
      DO 3658 K=1,3                                                     COST4050
      XOM(K)=XCHRS*(ELCC*ELCS)+FUELQ*FUELS +SHRS                        COST4060
     .     +EI(K)    *3.        *365.*POL(K)                            COST4070
 3658     CONTINUE                                                    COST4080
          GO TO 4300                                                  COST4090
C         ONE- OR TWO-STEP PRESSURIZED COMBUSTION                     COST4100
 3660     CONTINUE                                                    COST4110
          DO 3668 K=1,3                                               COST4120
          XOM(K)=-.02*FUELQ*FUELS+1.5E-6*RR(K)                        COST4130
 3668     CONTINUE                                                    COST4140
          GO TO 4300                                                  COST4150
C         FLUE GAS DESULFURIZATION - ALKALIZED ALUMINA                COST4160
 3670     CONTINUE                                                    COST4170
          DO 3678 K=1,3                                               COST4180
          XOM(K)=1.06*XOHRS*PR(1)/24.                                 COST4190
 3678     CONTINUE                                                    COST4200
          GO TO 4300                                                  COST4210
C         FLUE GAS DESULFURIZATION - LIMESTONE (DRY)                  COST4220
 3680     CONTINUE                                                    COST4230
          DO 3688 K=1,3                                               COST4240
          XOM(K)=XOHRS*PR(1)/24.*(.17+7.0 *OFSC1(1)*CATS)             COST4250
 3688     CONTINUE                                                    COST4260
          GO TO 4300                                                  COST4270
C         FLUE GAS DESULFURIZATION - LIMESTONE (WET)                  COST4280
 3690     CONTINUE                                                    COST4290
          DO 3698 K=1,3                                               COST4300
          XOM(K)=XOHRS*PR(1)/24.*(.196+ 3.82*OFSC1(1)*CATS)+130000.COST4310
 3698     CONTINUE                                                    COST4320
C         MAGNETC HYDRO DYNAMICS                                      COST4330
 3710     CONTINUE                                                    COST4340
          DO 3718 K=1,3                                               COST4350
          XOM(K)=-.539*FUELQ*FUELS+1.5E-6*RR(K)                       COST4360
 3718     CONTINUE                                                    COST4370
          GO TO 4300                                                  COST4380
C         ELECTRC GAS DYNAMICS                                        COST4390
 3720     CONTINUE                                                    COST4400
          DO 3728 K=1,3                                               COST4410
          XOM(K)=-.282*FUELQ*FUELS+1.2E-6*RR(K)                       COST4420
 3728     CONTINUE                                                    COST4430
          GO TO 4300                                                  COST4440
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C     FUEL DESLLFURIZATION - COAL SCRUBBEP                              COST4450
 3730 CONTINLE                                                          COST4460
      DO 3738 K=1,3                                                     COST4470
      XOM(K)=.C65+.037*CFSC1(1)                                         COST4480
 3738 CCNTINLE                                                          COST4490
      GC TC 43CC                                                        COST4500
C     BY-PRCCLCT MANUFACTUPE - SULFUR PLANT                             COST4510
 3740 CONTINLE                                                          COST4520
      DC 374E K=1,1                                                     COST4530
      EIKKK=EI(K)*365.                                                  COST4540
      XOM(K)=3.685-.C365*EIKKK+.00025*(EIKKK*EIKKK)/2.                  COST4550
 3748 CCNTINLE                                                          COST4560
      XCM(1)=XCM(1)*3.                                                  COST4570
      GO TC 43C0                                                        COST4580
C     TALL STACKS                                                       COST4590
 3750 CCNTINUE                                                          COST4600
      DO 3758 K=1,3                                                     COST4610
      IF (STKHTM.GT.700.) GO TO 3756                                    COST4620
      XOM(K)=.04*CCSTIN                                                 COST4630
      GO TO 3758                                                        COST4640
 3756 CONTINUE                                                          COST4650
      XOM(K)=.03*COSTIN                                                 COST4660
 3758 CCNTINUE                                                          COST4670
      GC TC 43C0                                                        COST4680
C     AUTO EXHALST CONTROL CEVICE                                       COST4690
 3760 CONTINUE                                                          COST4700
      DC 3768 K=1,3                                                     COST4710
      XOM(K)=70.                                                        COST4720
 3768 CONTINLE                                                          COST4730
 4300 CCNTINUE                                                          COST4740
      DO 440C K=1,3                                                     COST4750
      TAC=TAC+XCM(K)/3.                                                 COST4760
 4400 CONTINUE                                                          COST4770
      DO 444C K=1,3                                                     COST4780
      EFFN(K)=DEVEFF(K)/100.                                            COST4790
 4440 CONTINLE                                                          COST4800
C                                                                       COST4810
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 4500     CONTINLE                                                        COST4820
          DO 446C K=1,3                                                   COST4830
          EMN(K)=(1.-EFFN(K))*EMRAT(3,K)                                  COST4840
 4460     CONTINLE                                                        COST4850
          DO 452C J=1,3                                                   COST4860
          CER(J)=0.                                                       COST4870
          DENM=EMRAT(3,J)-EMN(J)                                          COST4880
          IF (DENM.LE.0.0) GO TO 4520                                     COST4890
          CER(J)=TAC/DENM/365.                                            COST4900
 4520     CONTINLE                                                        COST4910
          IF (MODE.EC.0) GC TO 4600                                       COST4920
C                                                                         COST4930
C         WRITE CCST RECORD FCR OUTPUT                                    COST4940
C                                                                         COST4950
          WRITE (IP,4555) ICD,(EFFN  (J),J=1,3),TAC,(EMN(J),J=1,3)        COST4960
     .         ,(CER(J),J=1,3)                                            COST4970
          IF (JFLG.EC.1) WRITE (IP,4565)                                  COST4980
          JFLG=0                                                          COST4990
C         GO TO 47C0                                                      COST5000
 4600     CONTINUE                                                        COST5010
C                                                                         COST5020
C         WRITE CCST RECORD FCR CONTROL                                   COST5030
C                                                                         COST5040
          WRITE (14'IN14,4625) JSIC,JSITE,ICD,TAC                         COST5050
     .         ,(EMRAT(3,K),K=1,3)                                        COST5060
     .         ,AFSC,(EFFN(K),K=1,3),CAP ,SBTU,FRTYPE,PRCRT(3,4,1)        COST5070
     .         ,STKHT,PRCUN,DUV(3)                                        COST5080
          IN14=IN14+1                                                     COST5090
 4700     CONTINUE                                                        COST5100
          IF (IDUMP.NE.1) GO TO 4720                                      COST5110
          CALL PCUMP (FUELS,PFAC(1,1,1),5,XOM(1),EMN(3),5)                COST5120
          WRITE (6,895)                                                   COST5130
          WRITE (6,CINPUT)                                                COST5140
          WRITE (6,EINPUT)                                                COST5150
          WRITE (6,895)                                                   COST5160
          WRITE (IP,4535)JSIC,JSITE,(EMRAT(3,K),K=1,3)                    COST5170
 4720     CONTINUE                                                        COST5180
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      IERR=4                                                            COST5190
      IF (XOHRS.LE.1.E-10) GC TC 7200                                   COST5200
      IF (IRTRN.EQ.1) GC TO 210C                                        COST5210
      GC TC 15C0                                                        COST5220
C                                                                       COST5230
 5000 CONTINLE                                                          COST5240
C                                                                       COST5250
C     FUEL SLBSTITLTICN                                                 COST5260
C                                                                       COST5270
      SCERA=EMRAT(3,1)                                                  COST5280
      IFT(1)=0                                                          COST5290
      NFT=C                                                             COST5300
      DO 510C K=1,3                                                     COST5310
      IF (PRCRT(3,K,1).EQ.0.0) GO TO 5100                               COST5320
      NFT=NFT+1                                                         COST5330
      IFT(NFT)=K                                                        COST5340
 5100 CCNTINLE                                                          COST5350
      IF (MFLC.EC.1) GC TO 5200                                         COST5360
      IFT1=IFT(1)                                                       COST5370
      IF ((IFT1.NE.3).AND.(IFT1.NE.0)) GO TO 5200                       COST5380
C     WRITE FUEL SLBSTITUTICN RECORD                                    COST5390
      WRITE (IP,5185) ICD                                               COST5400
 5185 FCRMAT (      T1C,'NO SUBSTITUTION PCSSIBLE, ICD',I5 )            COST5410
      GO TO 15C0                                                        COST5420
 5200 CONTINLE                                                          COST5430
      IERR=1                                                            COST544C
      IF (SOFBTU.LE.1.E-10) GC TO 7200                                  COST5450
      DO 540C M=1,3                                                     COST5460
      BTUWT(M)=OFBTU(M)/SOFBTU                                          COST5470
 540C CONTINLE                                                          COST5480
 5500 CONTINUE                                                          COST5490
      N=1                                                               COST5500
 5600 CONTINUE                                                          COST5510
C     COMPUTE POTENTIAL AND ACTUAL HEAT ENERGY OUTPUT                   COST5520
      CEFF=BTLWT(1)*BEFF(1,N)+BTUWT(2)*BEFF(2,N)                        COST5530
     *     +BTUWT(3)*BEFF(3,N)                                          COST5540
      DO 590C M=1,3                                                     COST5550
 5800         CONTINUE                                                     COST5560
              HEO(M)=PR(M)*CFHC1(M)*365.                                   COST5570
              BTUYR(M)=CEFF*HEO(M)                                         COST5580
 5900         CONTINUE                                                     COST5590
 6000         CONTINUE                                                     COST5600
              N1=N                                                         COST5610
              IF (N.EQ.2) GO TO 6200                                       COST5620
              N=2                                                          COST5630
              SBTU=0.                                                      COST5640
              DO 6100 M=1,3                                                COST5650
              SBTU=SBTU+BTUYR(M)                                           COST5660
 6100         CONTINUE                                                     COST5670
              IF (SBTU.LE.876.E+9) GO TO 5600                              COST5680
 6200         CONTINUE                                                     COST5690
              IF (MFLG.EQ.1) GO TO 2800                                    COST5700
              JFLG=0                                                       COST5710
              OFSCO=CFSC1(1)*BTUWT(1)+OFSC1(2)*BTUWT(2)                    COST5720
             +CFSC1(3)*BTUWT(3)                                            COST5730
              IF (OFSCO    .GT.AFSC    ) GO TO 6500                        COST5740
C             WRITE FUEL SUBSTITUTION MESSAGE                              COST5750
C             NOTE THAT SITUATION CANNOT BE IMPROVED HERE                  COST5760
              JFLG=1                                                       COST5770
 6500         CONTINUE                                                     COST5780
              SOER1=0.                                                     COST5790
              TAFC1=0.                                                     COST5800
C             COMPUTE ORIGINAL FUEL COST AND EMISSION RATE                 COST5810
              DO 6600 M=1,3                                                COST5820
              SOER1=PR(M)*CFSC1(M)* 2.                       +SOER1        COST5830
              TAFC1=365.*PR(M)*OFC(M)                        +TAFC1        COST5840
 6600         CONTINUE                                                     COST5850
              IERR=5                                                       COST5860
              IF (TAFC1.LE.1.E-10) GO TO 7200                              COST5870
              DSCER1=SCERA-SOER1                                           COST5880
C             DETERMINE NEW FUEL QUANTITY REQUIREMENTS                     COST5890
              M=1                                                          COST5900
              IF ((ICD.GE.30).AND.(ICD.LE.32)) M=2                         COST5910
              IF ((ICD.GE.33).AND.(ICD.LE.34)) M=3                         COST5920
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      IERR=2                                                            COST5930
      IF (AFHC.LE.1.E-1C) GO TO 7200                                    COST5940
      AFQ=SBTL/(AFHC     *BEFF(M,N1))                                   COST5950
C     DETERMINE NEW SULFUR EMISSION RATE                                COST5960
      SOER2= AFC*AFSC*2./365.                                           COST5970
C     DETERMINE SULFUR EMISSION RATE CIFFERENCE                         COST5980
      DSCER2=SCERA-SOER2                                                COST5990
      IERR=3                                                            COST6000
      IF (SOERA.LE.1.E-10) GC TC 7200                                   COST6010
      SOEFF=CSCER2/SOERA                                                COST6020
C     COMPUTE NEW FUEL CCST                                             COST6030
      IERR=6                                                            COST6040
      IF ( AFC .LE.1.E-10) GC TO 720C                                   COST6050
      TAFC2=AFC*AFC                                                     COST6060
C     COMPUTE INCREASE IN ANNUAL FUEL COST                              COST6070
      DTFC=TAFC2-TAFC1                                                  COST6080
      TAC=DTFC+EXFSC                                                    COST6090
      EFFN(1)=SCEFF                                                     COST6100
      ITY=2                                                             COST6110
      IF (JSIC.EC.4911) ITY=1                                           COST6120
      DO 680C IPL=2,3                                                   COST6130
      EFFN(IPL)=C.                                                      COST6140
      IF (EMRAT(3,IPL).LE.0.) GC TO 6800                                COST6150
      FF=(1.-CCNEFF/1CC.)                                               COST6160
      IF (IPL.EC.2) FF=1.                                               COST6170
      EFFN(IPL)=(EMRAT(3,IPL)/FF-AFQ*PFAC(M,IPL,ITY)/730000.)           COST6180
     *          /(EMRAT(3,IPL)/FF)                                      COST6190
 6800 CONTINUE                                                          COST6200
      GO TO 45CC                                                        COST6210
 7200 CONTINUE                                                          COST6220
      WRITE (IP,7235) ICD,ERROR(IERR)                                   COST6230
      IF (IRTRN.EQ.1) GO TO 2100                                        COST6240
      GC TO 15C0                                                        COST6250
 9000 CONTINUE                                                          COST6260
      IS13=IN13                                                         COST6270
      IS14=IN14                                                         COST6280
      WRITE (13'IN13,1025) ITEND,ITEND,((ZE),I=1,5)                     COST6290
     .          ,((IZE),I=1,3)                                      COST6300
                WRITE (14'IN14,4625) ITEND,ITEND,IZE,((ZE),I=1,10),BLK   COST6310
     .              ,ZE,ZE,IZE,ZE                                   COST6320
                IF (ICUMP.NE.1) RETURN                              COST6330
                IN13=1                                              COST6340
                IN14=1                                              COST6350
                DO 910C I=1,IS13                                    COST6360
                READ (13'IN13,9115) CHARO                           COST6370
                IN13=IN13+1                                         COST6380
  9100          WRITE ( 6,S125) CHARO                               COST6390
                DO 920C I=1,IS14                                    COST6400
                READ (14'IN14,9115) CHARO                           COST6410
                IN14=IN14+1                                         COST6420
  9200          WRITE ( 6,S125) CHARC                               COST6430
                RETURN                                              COST6440
C                                                                   COST6450
C                                                                   COST6460
   895          FORMAT ( 1H1 )                                      COST6470
  1015          FORMAT ( 3I4,2I1,F3.1,A1,E7.3,E7.3,E8.3,E7.3,32X,I1)    COST6480
   991          FORMAT ( I4, I4, I3, F2.1, 3F5.2, F4.1, F4.1, F4.1, F4.0 COST6490
     2              , F4.0, 6F5.0, F5.0, 6F5.2, F7.2, F7.1, F4.3, F4.1  COST6500
     3              , F4.1, F4.1, F6.3, F6.3, F8.5, F3.0, F3.0, F3.0    COST6510
     4              , F3.0, F3.C, F3.0, F3.0, F3.0, F3.0, F2.0, F2.0    COST6520
     5              , F4.C, F5.3, 3F6.2, F6.1, F6.0, F4.0, F4.0, F5.0   COST6530
     6              , F4.0, F7.2, F5.0, F6.1, F4.0, 3F4.0, F4.0, F5.2   COST6540
     7              , F6.2, F4.C                                      ) COST6550
   995          FORMAT ( I4, I4, A1, F5.1, F5.1, F6.1, F5.1, F5.1, A1   COST6560
     2              , 6F2.1, F2.1, F2.1, I1, 2A1, F3.0, F5.2, F4.1      COST6570
     3              , F4.C, F6.1, F1.0, F1.0, F3.1, I2, F4.1,3F6.1      COST6580
     4              , 3F7.3, F7.3, F6.1, 3F6.1, 3F7.3,  F7.3, F6.1      COST6590
     5              , 3F6.1, 3F7.3, F7.3, F6.1, 3F3.0, 12F7.2,          COST6600
     X               SF6.2   )                                          COST6610
  4515          FORMAT(T01,'1',T38,'CONTRCL COST-EFFECTIVENESS REPCRT'/) COST6620
  4535          FORMAT (T15,'SIC=',T20,I5,T30,'SITE=',T36,I5,           COST6630
     2              T56,'CRIGINAL EMISSICNS'    /                       COST6640
     3              T54,'SCX',T63,'CO',T74,'PART'  /                    COST6650
     4              T48,3F10.3    /         T49,10('---')   //          COST6660
     5              T05,'DEVICE', T17,'EFFICIENCIES',T42,'COST',         COST6670
     6              T55,'CONTROLLED EMISSIONS',T86,'EFFECTIVENESS ($/',  COST6680
     7T103,'TON) '/ T14,'SOX',T23,'CO',T29,'PART', T41,'DOLLARS',        COST6690
     8              T54,'SOX',T63,'CO',T74,'PART',                       COST6700
     9              T86,'SOX',T95,'CO',T106,'PART'    /  )               COST6710
 4555          FORMAT ( T06,I3,T11,3F8.3,T36,F12.2,T48,3F10.3,           COST6720
     2              T80,3F10.2   )                                       COST6730
 4565          FORMAT ( T01,'+',T113,'**' )                              COST6740
 1025          FORMAT (2I10,5E14.7,3I10,140X,60A4)                       COST6750
 4625          FORMAT (3I10,10E14.7,A1,2E14.7,I10,E14.7,37X,60A4)        COST6760
 7235          FORMAT ( T06,I3, T25,'DATA MISSING... ', A8 )             COST6770
 9115          FORMAT ( 125A4 )                                          COST6780
 9125          FORMAT ( 5(5X,25A4/)  )                                   COST6790
               END                                                       COST6800
/*
```

A.3 ABATEMENT STRATEGY MODEL

```
      SUBROUTINE ABATE
C                        ABATEMENT STRATEGY MODEL
C
      DIMENSION TEFF(3)
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3).ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              AQSTAN(2,3,3),PERCNT(3)
      COMMON /DOL/IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INDX1,INDX2
     1 ,ICNT12,NSCRCE
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),CPOLUT(3,3,20),
     1              PTCON(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /SELCT/ISEL12(3,3,12),NSEL12,ISEL(3,3,5),NSEL5,XP(3,3,12)  SEL12C01
      COMMON/STRAT/NSIC(200),NSITE(200),COSTN(200),EFFN(200,3),EFFI(3),
     1 NCD(200),EMRN(200,3),TEM(3),SCONTR(3),LSTRAT,SULCON,LFUEL,AORD,
     2 ABS,SLOPE,ABSB,EMRI(3),           TCOST,REDUC(200,3),TRED(3)
C
      DEFINE FILE 13(1999,500,E,JREC),14(1999,500,E,IREC)
      JREC = 1
      ISVREC = 0
      NSRC = 0
   10 READ (9)           IPOLU1,IPOLU2,ISKIPP,NRECEP,NSCRCE
     1          ,(STAND(K,3),K=1,3)
      IFLG = 0
      IP = 0
      DO 7 IRECEP=1,237
      DO 7 J=1,3
    7 CPOLUT(J,3,IRECEP) = 0.0
      LSTRAT = 0
   15 TCOST = 0.0
      KP = 0
      EFFM = 0.0
      DO 5  I =1,200
      NSIC(I) = 0
      NSITE(I)= 0
      COSTN(I)= .999999E+10
      NCD(I)= 0
      DO 5 K = 1,3
      EMRN(I,K) = 0.0
      EFFN(I,K) = 0.0
      TEM(K) = 0.C
      TEFF(K) = C.0
    5 CONTINUE
C
      IF (LSTRAT .EQ. 5) GO TO 5C
      J = IPOLU1
C READ A STRATEGY RECCRC
      READ (13'JREC,9550) LTYPE,LSTRAT,SULCON,       ACRC,
     1   ABS,SLOPE,ABSB,NSRC,INCX1,INDX2
C
      SULCON = .01
      IF (LTYPE  .EQ. 5999) GO TC 7190
C DETERMINE IF PREVIOUS SCURCES TO BE USED.
      IF (LTYPE .EQ. 2) GC TO 20
C
C IF THIS IS INITIAL ENTRY SET IREC = INDX1.
      IF (IFLG .EQ. 1) GC TO 30
      IREC = INDX1
      GO TO 30
C SET IREC = ISVREC FCR LTYPE=2.   ISVREC =0 IS AN ERRCR.
   20 IF (ISVREC .EQ. C) GC TO 6020
      IREC = ISVREC
      GO TO 5C
C
C SAVE IREC
C
   30 ISVREC = IREC
C
C GO TO STRATEGY SECTICN PICKED FOR THIS EXECUTION.
C
   50 GO TO (60,6C,7C,8C,9C),LSTRAT
   60 CALL STRAT1
      GO TO 7000
   70 CALL  STRAT3
      GO TO 7000
   80 CALL  STRAT4
      GO TO 7000
   90 CALL  STRAT5
C
 7000 DO 7100 I=1,M
      IF (NSIC(I) .EQ. 0) GO TO 7140
      CALL ECOUT (LSTRAT,J,NSIC(I),COSTN(I),KP)
C
C COMPUTE NEW EMISSION RATES.PER POLLUTANT
      REDUC(I,J) = EMRN(I,J) * EFFN(I,J)
C
      EMRN(I,J) =  EMRN(I,J) * (1. - EFFN(I,J))
      TEFF(J) = TEFF(J) + EFFN(I,J) * 100.
C
C SUM NEW EMISSION RATES PER POLLUTANT.
C
      TEM(J) = TEM(J) + EMRN(I,J)
C
C SUM DEVICE COSTS PER SOURCE.
C
      TCOST = TCOST + AINT(COSTN(I)) / 10**6
C
 7100 CONTINUE
 7140 TRED(J) = TEFF(J) / M
      IF (NSIC(1) .LE. 0) GO TO 7160
      IP = IP + 1
C
 7150 CALL  SRCOUT
C
      CALL  RECOUT
      IF (NSEL12 .NE. 1) GO TO 7160
      IF ( ICNT12.LE. 0) GO TO 7160
      CALL  SELOUT
 7160 IF (LSTRAT .NE. 5) GO TO 7180
      IREC = INDX1
```

```
C
      J= J + ISKIPP
      IF (J .GT. IPOLL2) GO TO 7180
C
      GO TO 15
C PLOT NEW GROUND LEVEL CONCENTRATIONS.
C
 7180 NRECEP = NRECEP - IADD
      DO 7185 K=1,IP
      CALL PLOTN
 7185 CONTINUE
C
 6020 IERR = 2
      REWIND 9
      GO TO 10
 7190 REWIND 9
      RETURN
 9990 FORMAT(2I10,5E14.7,3I10)
  991 FORMAT(3I2,2I4,3E15.8,10X/)
      END
      SUBROUTINE STRAT1
C
C BEGIN FUEL SUBST.OR EQUIVALENT FUEL SUBST. SECTION.
C
      COMMON /DCL/IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPF,ISKIPT
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INDX1,INDX2
     1 ,ICNT12,NSORCE
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),DPOLUT(3,3,20),
     1               PTCON(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2               ,JRECEP(3,3,237)
      COMMON/STRAT/NSIC(200),NSITE(200),COSTN(200),EFFN(200,3),EFFI(3),
     1 NCD(200),EMRN(200,3),TEM(3),SCCNTR(3),LSTRAT,SULCON,LFUEL,ACRD,
     2 ABS,SLOPE,ABSB,EMRI(3),            TCOST,REDUC(200,3),TRED(3)
C
C SET  POLLUTANT INCREMENT FOR SOX ONLY.
 1000 J= 1
      M = 1
C
C INITIALIZE SOURCE LOOP.
      DO 1710 I = 1,NSRC
C
      IHOLD = IREC
C READ A COST RECORD.
 1010 IF (IREC .GT. INDX2) GO TO 1750
      READ(14'IREC,9991)ISIC,ISITE,ICD,COSTI,(EMRI(K),K=1,3),AFSC,
     1 (EFFI(K),K=1,3),ACFM,BTU,PTYPE,PRATE,HS,PRUN,SHIFTS
C
      IF (IFLG .EQ. 1) GO TO 1020
      JSIC = ISIC
      JSITE = ISITE
      IFLG = 1
      GO TO 1025
C
 1020 IF (ISIC - JSIC) 1500,1021,1500
 1021 IF (ISITE - JSITE) 1650,1025,1500
C
C IF DEVICE IS NOT FUEL SUBST. GET NEXT DEVICE.
```

```
C
 1025 IF (ICD .LT. 27  .OR. ICD .GT. 37) GO TO 1010
C
C IF ALT. FUEL SULFUR CONTENT NOT EQUAL OR LESS THAN
C          STRATEGY SULFUR CONTENT GET NEXT DEVICE.
C
       IF (AFSC .GT. SULCON) GO TO 1010
C
C BRANCH DEPENDING ON STRATEGY
C
       GO TO (1100,1150),LSTRAT
C
C  FUEL SUBST. STRATEGY CONTINUES
C
C  FIND FUEL SUBSTITION WITH LEAST COST.
C
 1100 IF (COSTN(M)   .LE. COSTI )   GO TO 1010
C
C REPLACE SAVED DEVICE WITH NEW DEVICE OF LESS COST FOR FUEL SUBST. OR
C                      GREATEST EFFICIENCY FOR EQUIV. FUEL SUBST.
 1200 NSIC(M) = ISIC
      NSITE(M) = ISITE
      NCD(M) = ICD
      COSTN(M)  =  COSTI
      EMRN(M,J) = EMRI(J)
      EFFN(M,J) = EFFI(J)
      GO TO 1010
C
C  DO EQUIVALENT FUEL SUBSTITUTION  TEST FOR MOST EFFICIENT FUEL SUBST.
C
 1150 IF (EFFI(J) .LE. 0.0) GO TO 1010
      IF (EFFM .GE. EFFI(J)) GO TO 1010
      EFFM = EFFI(J)
      GO TO 1010
C  IF STRATEGY IS EQUIV. FUEL SUBST. FIND DEVICES, OTHER THAN FUEL
C     SUBST. DEVICES WHICH ARE AS EFFICIENT OR MORE EFFICIENT THAN THE
C     FUEL SUBST. DEVICE PICKED ABOVE. IF STRATEGY IS FUEL SUBST. TOTAL
```

```
C      COST & EMISSION RATE AND GET NEXT SOURCE.
C
 1500 IF (LSTRAT .EQ. 1) GO TO 1700
      IF (EFFM .LE. 0.0) GO TO 1700
C
 1550 IREC = IHOLD
C
 1560 IF (IREC .GT. INDX2) GO TO 1750
      READ(14'IREC,9991)ISIC,ISITE,ICD,COSTI,(EMRI(K),K=1,3),AFSC,
     1 (EFFI(K),K=1,3),ACFM,BTU,PTYPE,PRATE,HS,PRUN,SHIFTS
C
 1570 IF (ISIC - JSIC) 1700,1571,1700
C
 1571 IF (ISITE - JSITE) 1650,1580,1700
C
 1580 IF (ICD .GE. 27 .AND. ICD .LE. 37) GO TO 1560
C
 1590 IF (EFFM .GT. EFFI(J)) GO TO 1560
C
 1600 IF (COSTN(M) .LE. COSTI) GO TO 1560
C
C
      NSIC(M) = ISIC
      NSITE(M) = ISITE
      NCD(M) = ICD
      COSTN(M) = COSTI
      EMRN(M,J) = EMRI(J)
      EFFN(M,J) = EFFI(J)
      GO TO 1560
C
 1650 IERR = 1
      GO TO 1750
 1700 IFLG = 0
      IREC = IREC - 1
      IF (NSIC(M) .GT. 0) M = M + 1
 1710 CONTINUE
 1750 RETURN
```

```
9991 FORMAT(3I1C,10E14.7,A1,2E14.7,I10,E14.7)
     END
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```
      SUBROLTINE STRAT3
C
C STRATEGY 3-- NCN-COMBLSTICN SCLRCE PARTICULATE RECUCTICN.
C     STRATEGY IS: IF PROCESS RATE(P)< 30TONS/HR.
C                          PARTICULATE EMISSION MUST BE < 4.1*P**.67
C                    IF P > 3C TCNS/HR THEN EMISSICN MUST BE < 55*P**.11
C                                                                - 4C.
C
      COMMON /DOL/IPCLL1,IPCLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INCX1,INDX2
     1 ,ICNT12,NSORCE
      COMMCN /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),OPCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON/STRAT/NSIC(2CC),NSITE(200),COSTN(200),EFFN(20C,3),EFFI(3),
     1 NCD(200),EMRN(2CC,3),TEM(3),SCCNTR(3),LSTRAT,SULCON,LFUEL,AORD,
     2 ABS,SLOPE,ABSB,EMRI(3),            TCOST,REDUC(200,3),TRED(3)
      DATA EF,EYE/'F','I'/
 2000 J = 3
      M = 1
C
 2010 DO 2900 I=1,NSRC
C
 2050 IF (IREC .GT. INCX2) GC TC 295C
      READ(14'IREC,9991) ISIC,ISITE,ICD,COSTI,(EMRI(K),K=1,3),AFSC,
     1 (EFFI(K),K=1,3),ACFM,BTL,PTYPE,PRATE,HS,PRUN,SHIFTS
C
      IF (IFLG .EQ. 1) GC TC 21C0
      JSIC = ISIC
      JSITE = ISITE
      IFLG = 1
C
 2100 IF (ISIC .NE. JSIC) GC TC 2800
C
 211C IF (ISITE - JSITE) 275C,212C,28C0
C
 2120 IF (PTYPE .EQ. EF .CR. PTYPE .EQ. EYE) GC TC 205C
```

```
C
 2130 IF (EMRI(J) .LE. C.) GC TC 2050
      HOURS = 8. * SHIFTS
C
 2140 IF (PRUN .NE. 1.) GC TC 2145
      PRATE = PRATE / HOURS
      GO TO 2160
C
 2145 IF (PRUN .NE. 2. ) GC TC 2150
      PRATE = .3 * PRATE / HCURS
      GO TO 2160
C
 2150 IF (PRUN .NE. 3. ) GC TC 2155
      PRATE = 1.88 * PRATE / HCLRS
      GO TO 2160
 2155 IF (PRUN .NE.  8.) GO TC 2050
      PRATE = 147. * PRATE / HCLRS
 2160 IF (PRATE .GT. 3C.) GC TC 2190
      E = 4.1 * (PRATE * 2CCC.)**.67
      GO TO 2200
C
 2190 E =(55. * (PRATE * 20C0.)**.11) - 40.
C
 2200 EM = EMRI(J) * (2CCC./HOLRS)
C
 2210 IF (E .GE. EM) GC TC 205C
C
 2220 EM = EM * (1. - EFFI(J))
C
 2230 IF (EM .GT. E) GC TC 205C
C
 2240 IF (COSTI .GE. CCSTN(M)) GC TC 205C
C
 2250 NSIC(M) = ISIC
      NSITE(M) = ISITE
      NCD(M) = ICD
      EFFN(M,J) = EFFI(J)
      EMRN(M,J) = EMRI(J)
      COSTN(M) = COSTI
      GO TO 2050
C
 2750 IERR = 1
      GO TO 2950
C
 2800 IREC = IREC - 1
      IFLG = 0
      IF (NSIC(M) .GT. 0) M = M + 1
C
 2900 CONTINUE
C
 2950 RETURN
C
 9991 FORMAT(3I10,10E14.7,A1,2E14.7,I10,E14.7)
      END
      SUBROUTINE STRAT4
C
C STRATEGY 4 IS A COMBUSTION SOURCE PARTICULATE EMISSION RESTRICTION
C      BASED ON SOURCE HEAT OUTPUT (BTU/HR).
C                USING THE FORMULA:
C                                   D = 50*A*HS/2.22(CH**.75)* (10*X-3)
C                WHERE : D = LBS/10**6BTU
C                        A = 1 IF CH > 4*10**9 BTU/HR
C                        A = .8 IF HS > 150 FEET AND CH NOT > 4*10**9
C                     OR A = .67 IF HS < 150 FEET
C                        QH= HEAT OUTPUT OF SOURCE
C                        HS= STACK HEIGHTH
C
      COMMON /DOL/IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INDX1,INDX2
     1 ,ICNT12,NSORCE
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),CPOLUT(3,3,20),
     1              PICON(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON/STRAT/NSIC(200),NSITE(200),COSTN(200),EFFN(200,3),EFFI(3),
     1 NCD(200),EMRN(200,3),TEM(3),SCONTR(3),LSTRAT,SULCON,LFUEL,AORD,
     2 ABS,SLOPE,ABSB,EMRI(3),             TCOST,REDUC(200,3),TRED(3)
      DATA EF,EYE/'F','I'/
 3000 J = 3
      M = 1
 3010 DO 3800 I=1,NSRC
C
 3020 IF (IREC .GT. INDX2) GO TO 3900
      READ(14'IREC,9991) ISIC,ISITE,ICD,COSTI,(EMRI(K),K=1,3),AFSC,
     1 (EFFI(K),K=1,3),ACFM,BTU,PTYPE,PRATE,HS,PRUN,SHIFTS
C
      IF (IFLG .EQ. 1) GO TO 3050
      JSIC = ISIC
      JSITE = ISITE
      IFLG = 1
C
 3050 IF (ISIC .EQ. JSIC) GO TO 3060
```

```
      GO TO 3750
C
 3060 IF (ISIC - JSIC) 3700,3070,3750
C
 3070 IF (PTYPE .NE. EF) GO TO 3020
C
      IF (EMRI(J) .LE. 0.) GO TO 3020
      IF (BTU .LE. 0.) GO TO 3020
      IF (HS .LE. 0.) HS = 75.
C
C  COMPUTE QH; BTU/HR AND HSFT- STACK HEIGHT IN FEET
C
      QH = BTU /(8. * SHIFTS * 365.)
C
      HSFT = HS * 3.28083
C
      IF (QH .LT. (4.E+9)) GO TO 3100
      A = 1.
      GO TO 3150
C
 3100 IF (HSFT - 150.) 3120,3120,3130
C
 3120 A = .67
      GO TO 3150
C
 3130 A = .8
C
 3150 PDBTU = (2000. /(8. * SHIFTS)) * EMRI(J) / QH
C
      D = 73.892576 * A * HSFT /(2.22 * (QH**.75))
C
      IF ( D .GT. .6) D = .6
C
      IF (PDBTU .LE. D) GO TO 3020
      PDBTUN = PDBTU * (1. - EFFI(J))
      IF (PDBTUN .GT. D) GO TO 3020
      IF (COSTI .GE. COSTN(M)) GO TO 3020
```

```
C
C
      NSIC(M) = ISIC
      NSITE(M) = ISITE
      COSTN(M) = COSTI
      EMRN(M,J) = EMRI(J)
      EFFN(M,J) = EFFI(J)
      GO TO 3020
C
 3700 IERR = 1
      GO TO 3900
C
 3750 IREC = IREC - 1
      IFLG = 0
      IF (NSIC(M) .GT. 0) M = M + 1
 3800 CONTINUE
C
 3900 RETURN
C
 9991 FORMAT(3I10,10E14.7,A1,2E14.7,I10,E14.7)
      END
      SUBROUTINE STRAT5
C
C  STRATEGY 5-- ABATEMENT BY USE OF "BEST" DEVICE FOR MAXIMUM REDUCTION:
C
      COMMON /DOL/IPCLU1,IPCLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INDX1,INDX2
     1 ,ICNT12,NSORCE
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),CPCLUT(3,3,20),
     1              PTCON(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IACD
     2              ,JRECEP(3,3,237)
      COMMON/STRAT/NSIC(200),NSITE(200),COSTN(200),EFFN(200,3),EFFI(3),
     1 NCD(200),EMRN(200,3),TEM(3),SCONTR(3),LSTRAT,SULCON,LFUEL,AORD,
     2 ABS,SLOPE,ABSB,EMRI(3),           TCOST,REDUC(200,3),TRED(3)
C
      M = 1
 5010 DO 5210 I=1,NSRC
C
 5020 IF (IREC .GT. INDX2) GO TO 5250
      READ(14'IREC,9991) ISIC,ISITE,ICD, COSTI,(EMRI(K),K=1,3),AFSC
     1,(EFFI(K),K=1,3),ACFM,BTU,PTYPE,PRATE,HS,PRUN,SHIFTS
C
      IF (IFLG .EQ. 1) GO TO 5050
C
      JSIC = ISIC
      JSITE = ISITE
      IFLG = 1
      GO TO 5070
C
 5050 IF (ISIC - JSIC) 5200,5060,5200
C
 5060 IF (ISITE - JSITE) 5100,5070,5200
C
 5070 IF (EFFI(J) .LE. EFFN(M,J)) GO TO 5020
C
      NSIC(M) = ISIC
      NSITE(M)= ISITE
      NCD(M) = ICD
      COSTN(M) = COSTI
      EMRN(M,J) = EMRI(J)
      EFFN(M,J) = EFFI(J)
      GO TO 5020
C
 5100 IERR = 1
      GO TO 5250
C
 5200 IREC = IREC - 1
      IFLG = 0
      IF (NSIC(M) .GT. 0) M = M + 1
 5210 CONTINUE
 5250 RETURN
C
 9991 FORMAT(3I10,10E14.7,A1,2E14.7,I10,E14.7)
      END
      SUBROUTINE ECOUT (IS,IPOL,LSIC,COST,KP)
      IF (KP .EQ. 1) GO TO 20
      WRITE (7,99) IS,IPOL
   99 FORMAT(5X,'COST DATA PER SOURCE FOR STRATEGY ',I1,'POLLUTANT ',I1)
      KP = 1
   20 WRITE (7,999) LSIC,COST
  999 FORMAT (5X,I4,5X,E14.7/)
      RETURN
      END
      SUBROUTINE SRCOLT
C OUTPUT COSTS & EMISSIONS PER SOURCE AND TOTAL COST & EMISSIONS.
C
      DIMENSION PNAME(3)
      COMMON /DOL/IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPP,ISKIPT
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INDX1,INDX2
     1 ,ICNT12,NSCRCE
      COMMON /RCPT/ RECEPT(2,237),CPOLUT(3,3,237),CPCLUT(3,3,20),
     1              PTCON(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON/STRAT/NSIC(200),NSITE(200),COSTN(200),EFFN(200,3),EFFI(3),
     1 NCD(200),EMRN(200,3),TEM(3),SCONTR(3),LSTRAT,SULCON,LFUEL,AORD,
     2 ABS,SLOPE,ABSB,EMRI(3),          TCOST,REDUC(200,3),TRED(3)
      DATA PNAME/'SOX  CO PART'/
      KFLAG = 0
      LINE = 0
C
      I = 1
C
 7210 GO TO (7220,7230,7240,7240,7250),LSTRAT
C
C FUEL SUBSTITUTION STRATEGY OUTPUT FOR SOX REDUCTION.
C
 7220 WRITE (6,9994) PNAME(J),SULCON
C
      GO TO 7500
C
C EQUIVALENT FUEL SUBSTITUTION STRATEGY OUTPUT FOR SOX REDUCTION.
C
 7230 WRITE (6,9995) PNAME(J),SULCON
C
      GO TO 7500
C
C POLLUTANT REDUCTION AS A FUNCTION OF EFFLUENT GAS,STRATEGY 3, OUTPUT.
C
C STRATEGY 4, POLLUTANT REDUCTION AS A FUNCTION OF AMOUNT OF MATERIAL
C         BURNED (COMBUSTION SOURCES, OR MATERIAL USED (INDUSTRIAL
C         PROCESS), OUTPUT
C
 7240 WRITE (6,9996) FNAME(J)
C
      GO TO 7500
C
C STRATEGY 5 OUTPUT- POLLUTANT REDUCTION USING MAXIMUM EFFICIENCY ONLY.
C
 7250 WRITE (6,9998) FNAME(J)
C
 7500 IF (KFLAG .EQ. 1) GO TO 7540
      KFLAG = 1
      WRITE (6,9992) TCOST, TEM(J),TRED(J)
C
 7540 WRITE (6,9993)
 7550 EFFPER    = EFFN(I,J) * 100.
      WRITE (6,9999) NSIC(I),NSITE(I),NCD(I),EMRN(I,J),COSTN(I),
     1 EFFPER,REDUC(I,J)
      LINE = LINE + 1
      I = I + 1
      IF ( I .GT. M) GO TO 7600
      IF (NSIC(I) .EQ. 0) GO TO 7600
      IF (LINE .LE.  40)   GO TO 7550
      LINE = 0
      GO TO 7210
 7600 RETURN
C
 9992 FORMAT(' ',T10,'REGIONAL COST = $', F9.6,' MILLIONS'//T10,'REGIONA
     1L EMISSION = ',F7.3,' TONS/DAY',T50,'REGIONAL REDUCTION ',
     2F6.2,' %'/)
 9993 FORMAT(' ',T5,21('____')/T5,'|',T9,'SIC',T14,'|',T17,'SITE',T23,
     1 '|',T25,'DEVICE |',T34,'NEW EMISSION |',T51,'DEVICE',T61,'|  DEVI
     2CE  |',T76,'REDUCTION   |',
     3      /T5,'|  CODE  |',T18,'NO.  |',T27,'ID   |',T36,'TONS/DAY   |
     4',T52,'COST      |EFFICIENCY|',
     5T76,'TONS/DAY    |'/'+'T5,21('____'))
 9994 FORMAT('1',T20,'FUEL SUBSTITUTION STRATEGY SOURCE DATA'//T20,
     1 A4,' REDUCTION',T40,F6.3,' SULFUR CONTENT'/)
9995 FORMAT('1'T13,'EQUIVALENT FUEL SUBSTITUTION STRATEGY SOURCE DATA'/
     1/T20,     A4,' REDUCTION',T40,F6.3,' SULFUR CONTENT'/)
9996 FORMAT('1'T17,'SOURCE EMISSION STANDARD STRATEGY SOURCE DATA'//T31
     1,A4,' REDUCTION'/)
9998 FORMAT('1'T18,'MAXIMUM CONTROL TECHNOLOGY STRATEGY SOURCE DATA'//,
     1 T31,A4,' REDUCTION'/)
9999 FORMAT(' 'T5,'|',T8,I4,'  |  ',I4,'  |  ',I3,T32,'| ',E12.6,' | $'
     1 ,F9.0,T61,'| ',F6.2,' % |',T74,E12.6,T88,'|')
      END
      SUBRCLTINE RECOLT
C
C CALCULATE NEW RECEPTCP C.L.C.'S ANC COMPARE THEM TC THE AIR
C     QUALITY STANDARCS
C
      DIMENSICN NHOLD(5),HCLC(3)
      DIMENSION PNAME(3),PUNITS(3,2)
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GECMN(2,3,3),AVRGTM(5),
     2              ACSTAN(2,3,3),PERCNT(3)
      COMMON /DOL/IPOLL1,IPCLU2,ITIME1,ITIME2,ISKIPF,ISKIPT
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INCX1,INDX2
     1 ,ICNT12,NSORCE
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),OPCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IACD
     2              ,JRECEP(3,3,237)
      COMMON /SELCT/ISEL12(3,3,12),NSEL12,ISEL(3,3,5),NSEL5,XP(3,3,12)
      COMMON/STRAT/NSIC(2CC),NSITE(200),COSTN(200),EFFN(20C,3),EFFI(3),
     1 NCD(200),EMRN(2CC,3),TEM(3),SCCNTR(3),LSTRAT,SULCCN,LFUEL,AORD,
     2 ABS,SLOPE,ABSB,EMRI(3),           TCOST,REDUC(20C,3),TRED(3)
      DATA PNAME/'SOX  CC PART'/
      DATA PUNITS/' PPM FPMG/CU         M. '/
 80CC KREC = 2
      LINE = 40
      DO 9900 IRECEP=1,NRECEP
      READ (9) (RECEPT(L,IRECEP),L=1,2),IRP
C
 8010 I = 1
      CRED = C.0
      EXCESS = C.C
      DO 8500 ISCRCE=1,NSCRCE
C
      READ (9) ISICT,ISITET,(SCCNTR(L),L=IPOLU1,IPOLU2,ISKIPP)
C
      IF (ISICT .EQ. NSIC(I) .ANC. ISITET .EQ. NSITE(I)) GO TO 8020
C
      CPCLUT(J,3,IRECEP) = CPCLLT(J,3,IRECEP) + SCCNTR(J)
      GO TO 8500
C
 8020 CPOLUT(J,3,IRECEP) = CPCLLT(J,3,IRECEP) + SCCNTR(J)*(1.-EFFN(I,J))
      CRED = CRED + SCCNTR(J) * EFFN(I,J)
C
      I = I + 1
      IF (I .LE. M) GC TC 8500
C
      I = 1
C
 8500 CONTINUE
C
C COMPARE G.L.C.'S TC AIR QUALITY STANDARDS.
C
 8600 IF(CPOLUT(J,3,IRECEP).GT. STAND(J,3))
     1   EXCESS = CPOLLT(J,3,IRECEP) - STAND(J,3)
C
      IF (LINE .LT. 40) GC TC 8650
C
C     WRITE RECEPTOR CLTPLT HEADER
C
 8620 LINE = 0
      WRITE (6,995) LSTRAT,PNAME(J),(PUNITS(J,L),L=1,2),STAND(J,3)
C
C  WRITE RECEPTOR DATA LINE
C
 8650 WRITE (6,996) IRECEP,(RECEPT(L,IRECEP),L=1,2),CPOLUT(J,3,IRECEP),
     1 CRED,EXCESS
      LINE = LINE + 1
      ICNT12 = 0
      IF(NSEL12 .NE. 1) GC TC 8800
      DO 8750 L =1,12
      IRCP   = ISEL12(J,3,L)
      IF (IRCP   .GT. C) GO TO 8730
      ICNT12 = L - 1
      GO TO 8800
 8730 XP(J,3,L) = CPOLLT(J,3,IRCP)
 8750 CONTINUE
 8800 CONTINUE
C
 8900 CONTINUE
      REWIND 9
      READ (9) (NHOLD(L),L=1,5),(HCLD(L),L=1,3)
      RETURN
  995 FORMAT('1',T41,'GRCLND LEVEL CCNCENTRATIONS'///T10,'STRATEGY ',I1,
     1T21,'REDUCTION TC PCLLLTANT ',A4,2X,2A4//T10,'AIR QUALITY STANDARD
     2  ',E12.6///T10,22('____')/T1C,'|  RECEPTOR  |',
     3       T34,'LOCATICN',T51,'| CONCENTRATION |',T72,'AMOUNT',T82,'|
     4 AMOUNT IN  |',/T1C,'|',T23,'|',T3C,'X',T37,'|',T44,'Y',T51,'|',T5
     57,'VALUE',T67,'|',T72,'REDUCED',T82,'|',T87,'EXCESS',T97,'|'/'+',
     6 T10,22('____'))
  996 FORMAT(' ',T1C,'|',T15,I3,T23,'|  ',F9.2,'  |  ',F9.2,'  | ',E12.6
     1,'  |',T69,E12.6,T82,'|',T85,E12.6,T97,'|')
      END
      SUBROUTINE  SELCLT
C
      DIMENSION CPER(3),PUNITS(3,2),PNAME(3)                            SEL12001
      DATA PNAME/'SOX  CC PART'/                                        SEL12001
      COMMON /AIRQ/ AVTIME(2,3,3),STANDV(3,3),JFLAG(2,3,3),F(2,3,3),
     1              STAND(3,3),ARIMN(2,3,3),GEOMN(2,3,3),AVRGTM(5),
     2              ACSTAN(2,3,3),PERCNT(3)
      COMMON /DOL/IPOLL1,IPCLU2,ITIME1,ITIME2,ISKIPP,ISKIPT             SEL12001
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INDX1,INDX2
     1 ,ICNT12,NSORCE
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),ORCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON /SELCT/ISEL12(3,3,12),NSEL12,ISEL(3,3,5),NSEL5,XP(3,3,12)
C                                                                       SEL12001
      DATA PUNITS/' PFM FPMG/CL         M. '/                           SEL12001
C  SEL12 WILL COMPUTE,THE GEOMETRIC MEAN (GEOM), THE MAXIMUM
C     CONCENTRATION (CMAX), THE % CONCENTRATION FOR 3 PERCENTILES       SEL12001
C     (CPER) FOR 5 AVERAGING TIMES FOR THE 12 SELECTED RECEPTORS.       SEL12001
C                   SET AVE. TIME LOOP                                  SEL12001
      DO  10 K = 1,5                                                    SEL12002
C                  TEST FOR  NUMBER OF AVE.TIMES                        SEL12001
      IF (AVRGTM(K) .LE. 0.) GO TO 15                                   SEL12001
      NAVE = K                                                          SEL12001
   10 CONTINUE                                                          SEL12001
C                                                                       SEL12001
C   COMPUTE TOTAL TIME                                                  SEL12001
C                                                                       SEL12001
   15 TTIME = 8760.                                                     SEL12001
C                   START AVE. TIME LOOP.
   30 DO 200 K = 1,NAVE                                                 SEL12001
C                   COMPUTE STAND DEV. FOR AVE. TIME K.                 SEL12002
      IF (STANDV(J,3) .EQ. 0.) STANDV(J,3) = 1.                         SEL12002
      SIGK = STANDV(J,3)**(SQRT(ALOG(TTIME      /AVRGTM(K))
     1       / ALOG(TTIME       / 24.)))
C  COMPUTE EXPONENT FOR CONVERTING GEOM. MEAN TO AVE. TIME K.           SEL12002
      EXP = (ALOG(AVRGTM(K)/24.) * (.5 * ALOG(STANDV(J,3))))            SEL12002
     1       / ALOG(TTIME       / 24.)                                           SEL12002
C                                        WRITE HEADER LINE.                      SEL12001
      WRITE (6,990) PNAME(J),(PUNITS(J,N),N=1,2)
C                                                                                SEL12002
C   WRITE AVE. TIME, STAND DEV. AND COLUMN HEADINGS                              SEL12002
      WRITE (6,991) AVRGTM(K),SIGK, (PERCNT(N),N=1,3)                            SEL12002
C                                                                                SEL12002
C                             SET 12 RECEPTOR LOOP.                              SEL12002
      DO 200 L = 1,ICNT12
C                        GET RECEPTOR NUMBER FOR  POLUT                          SEL12002
      IRECEP = ISEL12(J,3,L)
C                                                                                SEL12002
C  COMPUTE GEOM. MEAN  USING ARITH. MEAN (XP)                                    SEL12002
      GEOM = XP(J,3,L) / STANDV(J,3)**(.5*ALOG(STANDV(J,3)))
C                                                                                SEL12002
C  COMPUTE  GEOM. MEAN AT AVE. TIME K                                            SEL12002
      GEOM = GEOM * STANDV(J,3)** EXP
C                                                                                SEL12002
C  COMPUTE MAXIMUM CONCENTRACTION FOR AVE. TIME K.                               SEL12002
C                                                                                SEL12003
      FREQ = 0.6 / (TTIME       / AVRGTM(K))                                     SEL12003
C                                                                                SEL12003
      CALL ZVALU2(FREQ,ZFREQ)
C                                                                                SEL12003
      CMAX = GEOM * SIGK**ZFREQ                                                  SEL12003
C                                                                                SEL12003
C  COMPUTE PERCENTILE CONCENTRATION FOR 3 PERCENTILES.                           SEL12003
C                                                                                SEL12003
      DO 60 N = 1,3
      FREQ = PERCNT(N)/ 100.
C                                                                                SEL12003
C                        TEST FOR AN M PERCENTILE,SET C/P TO 0 IF M % = 0.SEL12003
      IF (FREQ .GT. 0.) GO TO 50                                                 SEL12003
      CPER(N) = 0.
      GO TO 60                                                                   SEL12003
C                                                                                SEL12003
   50 CALL ZVALU2(FREQ,ZFREQ)
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      CPER(N) = GEOM * SIGM**ZFREQ
   60 CONTINUE                                                          SEL12003
C               WRITE O/P DATA LINE                                     SEL12003
      WRITE (6,992) IRECEP,XP(J,3,L),GEOM,CMAX,(CPER(N),N=1,3)
C                                                                       SEL12003
  200 CONTINUE                                                          SEL12003
C                                                                       SEL12004
      RETURN                                                            SEL12004
C                                                                       SEL12004
  990 FORMAT('1',T39,'STATISTICAL DATA FOR SELECTED RECEPTORS',///,T3,  SEL12004
     1'POLLUTANT  ',A4,1X,2A4/T3,'ANNUAL '////)
C                                                                       SEL12004
  991 FORMAT(' ',T3,'AVERAGING TIME ',F4.0,' HRS. HAS STANDARD DEVIATION
     1 = ',F5.2//T3,28('____'),'___',/,T3,'RECEPTOR  |  ARITHMETIC  |  G
     2EOMETRIC   |     MAXIMUM     |       ',3(F5.1,'%      |       '),/,
     3 T13,'|',T19,'MEAN     |     MEAN     |  CONCENTRATION  |',
     4 3('   CONCENTRATION  |'),/,T3,29('----')/)
C                                                                       SEL12004
  992 FORMAT(' ',T5,I3,T14,1PE13.6,T30,1PE13.6,T46,1PE13.6,T64,1PE13.6,
     1 T82,1PE13.6,T100,1PE13.6,/)
C                                                                       SEL12004
      END                                                               SEL12004
      SUBROUTINE ZVALL2(P,Z)
      DATA A0,A1,A2,B1,B2,B3/2.515517,0.802853,0.010328,1.432788,
     1   0.189269,0.001308/
C
C     P=PERCENT VALUE EXPRESSED IN DECIMAL
C
C     Z=REDUCED NORMAL VARIATE
C
      U=SQRT(ALOG(1./(P*P)))
      Z = U - (A0+U*(A1+U*A2))/(1. + U*(B1+U*(B2+U*B3)))
      RETURN
      END
      SUBROUTINE PLCTN
      DIMENSION ZMIN(3),ZMAX(3)
      COMMON /DOL/IPOLU1,IPOLU2,ITIME1,ITIME2,ISKIPF,ISKIPT
      COMMON /MISC/IREC,ISVREC,NSRC,J,IFLG,KREC,M,INCX1,INDX2
     1 ,ICNT12,NSCRCE
      COMMON /RCPT/ RECEPT(2,237),CPCLUT(3,3,237),CPCLUT(3,3,20),
     1              PTCCN(3,3,237),NRECEP,IRECEP,XRECEP(2,12),IADD
     2              ,JRECEP(3,3,237)
      COMMON/STRAT/NSIC(2CO),NSITE(20C),CCSTN(200),EFFN(200,3),EFFI(3),
     1 NCD(200),EMRN(200,3),TEM(3),SCONTR(3),LSTRAT,SULCON,LFUEL,AORD,
     2 ABS,SLOPE,ABSB,EMRI(3),             TCOST,REDUC(200,3),TRED(3)
C                                                                       DIFMOD2
      DATA ZMIN,ZMAX/3*9.CE+1C,3*-9.0E+10/
C     ********************PUNCH 1130 INPUT*******************************DIFMOD2
      WRITE (6,903)
  903 FORMAT(1H1)
      DO 10 IPOLUT=IPCLL1,IPCLL2,ISKIPP
      ZMIN(IPOLUT)= 9.0E+10
   10 ZMAX(IPOLUT) = -9.0E+10
      IF (LSTRAT .EQ. 5 ) GC TC 20
      IPOLU1 = J
      IPOLU2 = J
      ISKIPP = J
   20 DO 820 IRECEP = 1,NRECEP
      DO 820 IPOLUT =IPCLL1,IPCLL2,ISKIPP
      IF (ZMIN(IPOLUT) .GE. CPCLUT(IPCLUT,3,IRECEP))
     1          ZMIN(IPCLUT) = CPOLUT(IPOLUT,3,IRECEP)
      IF(ZMAX(IPOLUT) .LE. CPOLLT(IPCLUT,3,IRECEP))
     1          ZMAX(IPCLUT) = CPCLUT(IPOLUT,3,IRECEP)
  820 CONTINUE
      WRITE (6,901) (ZMIN(IPCLLT),IPOLUT=IPOLU1,IPCLU2,ISKIPP)
      WRITE (6,902) (ZMAX(IPCLLT),IPOLUT=IPOLU1,IPOLU2,ISKIPP)
C
C     LOOP ON RECEPTOR                                           IRECEP DIFMOD2
      DO  2050 IRECEP=1,NRECEP                                          DIFMOD2
      DO 2050 IPOLUT=IPCLL1,IPCLU2,ISKIPP
C     PUNCH A RECEPTOR CATA CARC                                        DIFMOD2
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```
      WRITE (7,72050) (RECEPT(L,IRECEP),L=1,2),CPOLUT(IPOLUT,       3,
     1             IRECEP)
72050 FORMAT (2P2F8.0,1X,3(5PF7.0,3PF5.0,8PF9.0))
 2050 CONTINUE
      WRITE (7,72055)                                                   DIFMOD2
72055 FORMAT ('¬¬')                                                      DIFMOD2
  901 FORMAT('0','MINIMA:',1X,8(E12.5,','),E12.5)                       DIFMOD2
  902 FORMAT('0','MAXIMA:',1X,8(E12.5,','),E12.5)
C
C     THE REMAINING CARDS FOR THE 1130 MUST BE PUNCHED BY HAND.          DIFMOD2
C     IF THE RANGE OF Z WERE TOO
C     GREAT, THE NUMBER OF CONTROL CARDS MAY BE INCREASED BY AN EVEN NUMBER.
C     FOR EXAMPLE IF THE RANGE WERE FROM 0 TO 5000, THE ENTIRE GRAPH MAY BE
C     PLOTTED AS A COMBINATION OF TWO SUPERIMPOSED GRAPHS, THE OUTER GRAPH
C     HAVING THE Z-VALUES FROM 0 TO 100, THE INNER GRAPH HAVING THE Z-VALUES
C     FROM 100 TO 5000, THUS FOUR CONTROL CARDS ARE NEEDED TO ACCOMPLISH THIS.
C     IF ANNOTATION IS NEEDED USE XEQ MAPAT.
C****************************1130 DATA HAS BEEN PUNCHED*****************DIFMOD2
      RETURN
      END
/*
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A.4 REGIONAL ECONOMETRIC MODEL

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C   REGIONAL ECONOMETRIC MODEL
C
      REAL A1(12)/244.585,27.688,10.998,-4.462,-344.071,21.522,-144.539,
     1        55.472,93.853,141.997,-468.752,230.314/,B1(12)/0.0284,
     2.00663,0.0152,0.0664,0.124,0.0151,0.0435,0.0155,0.0105,0.00539,
     3        0.130,0.003181/
      REAL A2(12)/0.639,1.143,1.143,0.553,0.553,1.320,0.688,0.972,0.781,
     1        0.708,0.809,0.949/,A3(12)/0.661,0.285,0.285,0.907,0.907,
     2        0.329,0.605,0.391,0.342,0.548,1.567,0.501/
      REAL BETA(12)/0.450,0.581,0.617,0.319,0.316,0.440,0.580,0.588,
     1        0.577,0.586,0.501,0.848/,DMINB(12)/0.550,0.419,0.383,0.681,
     2        0.684,0.560,0.420,0.412,0.423,0.414,0.499,0.152/
      REAL D7(12)/0.0674,0.0534,0.0686,0.0669,0.0614,0.0646,0.0560,0.070
     1       ,0.0722,0.0738,0.0784,0.0751/
      REAL A17(12)/-39.302,15.279,-11.361,79.910,120.806,160.527,-65.049
     1       ,-58.124,24.652,19.996,24.206,-294.34/,B17(12)/0.5970,0.7892
     2       ,0.4063,0.3252,0.2672,1.0533,1.3238,0.8176,0.1070,0.7681,
     3        0.4236,2.1780/,C17(12)/8.171,0.0,0.0,38.992,21.031,7.424,
     4        2.505,0.0,0.0,-1.450,8.095,1.665/
      REAL W20(12)/4.505,3.918,4.744,4.641,5.181,4.062,4.509,4.211,4.410
     1,4.305,4.662,3.283/,A20(12)/1.0413,1.0407,1.0343,1.0422,1.0409,
     21.0461,1.0474,1.0430,1.0419,1.0323,1.0519,1.0562/
      INTEGER TIME(20)/1953,1954,1955,1956,1957,1958,1959,1960,1961,1962
     .,1963,1964,1965,1966,1967,1968,1969,1970,1971,1972/
      INTEGER T
C
C
C
C PURPOSE: FOR A GIVEN YEAR, SPECIFIED BY T,
C
C   (1) COMPUTE REGIONAL INCOME AND CONSUMPTION EXPENDITURES FOR EACH OF
C        12 MAJOR MANUFACTURING CATEGORIES IN THE ST. LOUIS AREA, WITHOUT
C        INCORPORATING AIR POLLUTION CONTROL COSTS IN THE EQUATIONS.
C
C   (2) COMPUTE THESE QUANTITIES AGAIN, THIS TIME INCLUDING THE CONTROL
C        COSTS, IN ORDER TO DETERMINE EFFECT OF THIS COST ON THE MANUFACTURING
C        INDUSTRIES INVOLVED.
```

```
C
C      NEEDED TO OBTAIN THIS INFCRMATION ARE EXPORTS, IMPORTS, INVESTMENTS,
C        AND GOVERNMENT EXPENDITURES( THE LATTER A FUNCTION OF TAX REVENUE).
C        USING GIVEN INPLT CATA, THESE WILL BE COMPUTEC WITHIN THE PROGRAM.
C
      CONTINUE
C
C      THE 12 MAJCR MANLFACTLRING CATEGORIES ARE AS FCLLOWS:
C
C            INDUSTRY I=1   IS  FCOD AND KINDRED PRODUCTS
C                     I=2   IS  PAPER AND ALLIED PRODUCTS
C                     I=3   IS  PRINTING AND PUBLISHING
C                     I=4   IS  CHEMICAL AND ALLIED PRCDUCTS
C                     I=5   IS  PETROLEUM AND COAL PRCDUCTS
C                     I=6   IS  STCNE, CLAY, AND GLASS PRODUCTS
C                     I=7   IS  PRIMARY METAL INDUSTRIES
C                     I=8   IS  FABRICATED METAL PRODUCTS
C                     I=9   IS  MACHINERY, EXCEPT ELECTRICAL
C                     I=1C  IS  ELECTRIC MACHINERY
C                     I=11  IS  TRANSPORTATION EQUIPMENT
C                     I=12  IS  CTHER MANUFACTURING INDUSTRIES
C
      CONTINUE
C
C
C ** INPUT ** T   = YEAR FCR WHICH QUANTITIES ARE BEING COMPUTED, WITH
C                        T = 0  DENOTING 1954
C                        T = 1  DENOTING 1955
C                               ETC.
C
C          ** YN(I),I = 1,...,12      = NATIONAL INCCME BY SECTOR I ($MILLION)
C          ** K(I),I = 1,...,12 AT TIME T-1
C                                     = CAPITAL STCCK OF INDUSTRY FOR
C                                       THE YEAR T-1 ($MILLION)
C          ** CAPITAL T   =  LOCAL TAX REVENUE ($MILLION)
C          ** UN     =  NATICNAL UNEMPLOYMENT RATE (PERCENTAGE)
```

```
C            ** COC(I), I = 1, 12       = CONTROL CCST FOR INDUSTRY I
C
      CONTINUE
C
C        (NOTE: THERE IS AN OPTICN IN THIS PROGRAM TC CCMPUTE THE VARIABLES
C          FOR A SEQUENCE OF YEARS; 'INIT' DENOTES FIRST YEAR TO BE CONSIDERED,
C          'LAST' DENCTES THE LAST, AND 'INCRT' IS THE INCREMENT BETWEEN YEARS.)
C
C
C     ** OUTPUT **  G    =  LOCAL GOVERNMENT EXPENDITURE ($MILLION)
C               **  C    =  CCNSUMPTION ($MILLION)
C               **  Y*   =  REGICNAL EXPENDITURE ($MILLION)
C               **  Y    =  REGICNAL INCCME ($MILLION)
C               **  N-BAR  =  EMPLOYMENT BY INDUSTRIES CTHER THAN MANUFACTURING
C                             INDUSTRIES (1000)
C               **  N    =  TCTAL EMPLOYMENT (1000)
C               **  L    =  TOTAL LABCR FORCE (1000)
C               **  U    =  UNEMPLCYMENT (1000)
C               **  SMALL U  =  LOCAL EMPLOYMENT RATE (PERCENT)
C               **  QC   =  ELECTRIC POWER DEMAND FCR RESIDENTIAL USE
C                                           ( 1000 KILCWATT HOURS)
C               **  Q-BAR  =  ELECTRIC POWER DEMAND FCR NON-MANUFACTURING
C                             INDUSTRIES ( 1000 KILCWATT HOURS)
C               ** W(I), I = 1,...,12    = WAGE PER MAN-YEAR
C                                            BY INDUSTRY I ($THOUSAND)
C
      CONTINUE
C
C        TO OBTAIN THESE CESIRED QUANTITIES, THE FOLLOWING ARE COMPUTED
C          AND OUTPUTTEC FOR I = 1,...,12:
C               **  E(I)  =  EXPORT BY INDUSTRY I ($MILLION)
C               **  V(I)  =  VALUE ADDED BY INDUSTRY I ($MILLION)
C               **  M(I)  =  IMPCRT BY INDUSTRY I ($MILLION)
C               **  N(I)  =  EMPLCYMENT BY INDUSTRY I (1000)
C               **  K(I)  =  CAPITAL STOCK OF INDUSTRY I ($MILLION)
C               **  I(I)  =  INVESTMENT OF INDUSTRY I ($MILLION)
C               **  PI(I) =  CAPITAL SHARE OF VALUE ADDED OR
```

```
C                        PROFIT BY INDUSTRY I ($MILLION)
C              **  Q(I)  =  ELECTRIC POWER DEMAND BY INDUSTRY I (1000 KILOWATT
C                                                                       HOURS)
C
C
C
      CONTINUE
C
C PROCEDURE:    (1) READ IN THE COEFFICIENTS OF VARIABLES TO BE
C                        COMPUTED
C
C               (1) SET TIME = T
C
C               (2) READ AND WRITE INPUT VALUES THAT DEPEND ON T
C
C               (3) COMPUTE VARIABLES OF MODEL WITHOUT COST CONTROL
C                        FACTOR
C
C               (4) WRITE OUT THESE VARIABLES
C
C               (5) RECOMPUTE CERTAIN OF THESE VARIABLES USING COST
C                        CONTROL FACTOR
C
C               (6) WRITE OUT THESE VARIABLES
C
C               (7) CHANGE T IF DESIRED, AND REPEAT FROM (3)
C                        IF NO CHANGE IS DESIRED, END PROGRAM
C
C
C
C SUBROUTINES CALLED:
C
C               IVALUE(XI,PI,XKTPRE,T,XT,V)
C
C                   NOCEM(XI,E,XM,G,V,XN,UN,YSTAR,XC,YREG,XNBAR,
C                        XNTOT,XL,U,XLU,QC,QBAR)
      CONTINUE
```

```
C
C
C
C
      DIMENSION XKTPRE(12),YN(12),E(12),V(12),XM(12),PI(12),XK(12),
     1            XI(12),XN(12),C(12),XKNEW(12),COC(12),W(12),S(20)
      READ(5,300) S
  300 FORMAT (20A4)
      WRITE(6,301) S
  301 FORMAT ('1',20A4)
      READ(5,302) (INIT,LAST,INCRT)
  302 FORMAT(3I3)
C
      T = INIT
      XT = T
C
      WRITE(6,700)
  700 FORMAT ('1','A LISTING CF THE CONSTANTS USED TC COMPUTE THE OUTPUT
     1 VARIABLES FOLLCWS, WITH ADDITICNAL DOCUMENTATICN ASSOCIATING'//7X
     2 ,' EACH VARIABLE WITH ITS SET CF CONSTANTS.')
      WRITE(6,701)
  701 FORMAT (//5X,'TC CCMPUTE E(I) WE USE'/)
      WRITE(6,400) (I,A1(I),I,B1(I),I=1,12)
  400 FORMAT ('0',10X,' A1(',I2,') =',F15.6,20X,' B1(',I2,') =',F15.6)
      WRITE(6,702)
  702 FORMAT (//5X,'TC COMPLTE V(I) WE USE',20X,'TC CCMPUTE M(I) WE USE'
     1/)
      WRITE(6,401) (I,A2(I),I,A3(I),I = 1,12)
  401 FORMAT ('0',10X,' A2(',I2,') =',F15.6,20X,' A3(',I2,') =',F15.6)
      WRITE(6,703)
  703 FORMAT(//'1',T5,'TO CCMPUTE PI(I) WE USE',T50,'TC COMPUTE N(I) WE
     1USE'/)
      WRITE (6,403) (I,CMINB(I),I,BETA(I),I = 1, 12)
  403 FORMAT ('0',T12,'1 - BETA(',I2,') =',F15.6,T57,'BETA(',I2,') =',
     1           F15.6)
      WRITE(6,704)
  704 FORMAT('1',4X,'TC CCMPLTE K(I) WE USE'//)
```

```
      WRITE(6,405) (I,C7(I),I=1,12)
  405 FORMAT ('0',10X,' D7(',I3,') =',F15.6)
      WRITE(6,705)
  705 FORMAT(////5X,'TC CCMPLTE G(I) FCR I NOT EQUAL TC 2 WE USE'//)
      WRITE(6,41C) A17( 1), B17( 1), C17( 1)
  410 FORMAT ('0',10X,' A17( 1) =',F15.6,5X,' B17( 1) =',F15.6,5X,
     1           ' C17( 1) =' F15.6)
  406 FORMAT ('0',10X,' A17(',I2,') =',F15.6,5X,' B17(',I2,') =',F15.6
     1,5X,' C17(',I2,') =',F15.6)
      WRITE(6,406) (I,A17(I),I,B17(I),I,C17(I),I=3,12)
      WRITE(6,712)
  712 FORMAT ('1',T6,'TC CCMPUTE W(I) WE USE'//)
      WRITE(6,409) (I,W2C(I),I,A20(I),I=1,12)
  409 FORMAT ('0',T13,'W20(',I2,') =',F15.6,T62,'A2C(',I2,') =',F15.6)
C
 2001 READ(5,303) (XKTPRE(I),I=1,12)
  303 FORMAT (8F10.0)
      READ(5,304) (YN(I),I=1,12)
  304 FORMAT (10F8.0)
      READ(5,299)      CAPT,UN,(CCC(I),I=1,12)
  299 FORMAT (2F1C.0/(8F1C.0))
C
C
      NT  = T+1
      NET = T+2
      IT = T-1
      WRITE(6,706) T, TIME(NET),IT,TIME(NT)
  706 FORMAT ('1',T5,'TC CALCULATE I(I) AT TIME T =',I3,' (',I4,'), WE N
     1EED AS AN INPUT VALLE K(I) AT TIME T-1 =',I3,' (',I4,').'//T8,'THE
     2SE VALUES, CENOTED BY THE NAME KTPRE, ARE'//)
      WRITE(6,407) (I,XKTFRE(I),I=1,12)
  407 FORMAT ('0', T11 ,' KTPRE(',I2,') =',F15.6,T52,'KTPRE(',I2,') =',
     1           F15.6,T91,'KTPRE(',I2,') =',F15.6   )
      WRITE(6,707) T, TIME(NET)
  707 FORMAT (////T6,'ACDITICNAL REQUIRED INPUT, GIVEN AT TIME T =',I3,
     1          ' (',I4,') IS:'//)
      WRITE(6,408) (I,YN(I),I=1,12)
  408 FORMAT ('0',T11  ,' YN(',I2,') =',F15.6,T52,'YN(',I2,') =',F15.6,
     1            T91,'YN(',I2,') =',F15.6  )
      WRITE(6,708)      CAPT,UN
  708 FORMAT (///T12,'CAPITAL T =',F15.6,10X,' UN =',F15.6)
      WRITE(6,709)
  709 FORMAT (///7X,'THE COST OF CONTROL FOR EACH INDUSTRY (I) IS:'//)
      WRITE(6,399) (I, COC(I), I = 1, 12)
  399 FORMAT ('0', T11 ,' COC('  ,I2,') =',F15.6,T52,'COC('  ,I2,') =',
     1            F15.6,T91,'COC('  ,I2,') =',F15.6  )
C
C
C  COMPUTING VALUES WITHOUT CONTROL
C
      DO 1001 I=1,12
C   COMPUTE E(I)
      E(I) = A1(I)+B1(I)*YN(I)
C   COMPUTE V(I)
      V(I) = A2(I)*E(I)
C   COMPUTE M(I)
      XM(I) = A3(I)*V(I)
C   COMPUTE PI(I)
 1001 PI(I) = OMINB(I)*V(I)
C
C   COMPUTE I(I)
      CALL IVALUE(XI,PI,XKTPRE,T,XT,V)
C
      DO 1002 I=1,12
C   COMPUTE K(I)
      XK(I) = (XKTPRE(I)+XI(I))/(1. + D7(I))
C   COMPUTE W(I)
      W(I) = W20(I)*A2C(I)**XT
C   COMPUTE N(I)
      XN(I) = BETA(I)*V(I)/W(I)
C   COMPUTE Q(I)
      IF(I-2)600,601,600
  601 IF(XT.LT.6.0) GO TO 603
      Q(2) = -6.706 + 0.2978*V(2) + 5.759*XT
      GO TO 1002
  603 Q(2) = 37.414 + 0.2978*V(2) + 5.758*XT
      GO TO 1002
  600 Q(I) = A17(I) + B17(I)*V(I) + C17(I)*XT
 1002 CONTINUE
C
C   COMPUTE G
      G = 27.517 + .951*CAPT
C
C  COMPUTE Y*, C, Y, N-BAR, N, L, U, SMALL U, QC, Q-BAR
                 CALL NCDEM(XI,E,XM,G,V,XN,UN,YSTAR,XC,YREG,XNBAR,XNTOT,
     1                    XL,U,XLU,QC,QBAR)
C
C
      WRITE (6,450) T, TIME(NET)
  450 FORMAT ('1',10X,' FOR T =',I3,' (',I4,') WE HAVE THE FOLLOWING')
      WRITE(6,710)
  710 FORMAT(///15X,'(A) VALUES COMPUTED WITHOUT THE COST CONTROL FACTOR
     1'///)
      WRITE(6,417) (I,E(I),I,V(I),I=1,12)
  417 FORMAT ('0',T21, 'E(',I2,') =',F15.6, T68,'V(',I2,') =',F15.6)
      WRITE(6,419) (I,XM(I),I,PI(I),I = 1,12)
  419 FORMAT  (///('0',T21, 'M(',I2,') =',F15.6, T68,'PI(',I2,') =',F15.
     16))
      WRITE(6,422) (I,XI(I),I,XK(I),I = 1,12)
  422 FORMAT  ('1', T21,'I(',I2,') =',F15.6, T68,'K(',I2,') =',F15.6/
     1         ('0', T21,'I(',I2,') =',F15.6, T68,'K(',I2,') =',F15.6))
      WRITE(6,423) (I,XN(I),I,Q(I),I = 1,12)
  423 FORMAT (///('0',T21,'N(',I2,') =',F15.6,T68,'Q(',I2,') =',F15.6))
      WRITE(6,425) G,YSTAR,XC
  425 FORMAT   ('1', T21,'G =',F15.6, T63,'Y* =',F15.6,T102,'C =',F15.6)
      WRITE(6,428) YREG,XNBAR,XNTOT
  428 FORMAT(//'C', T21,'Y =',F15.6, T63,'N-BAR =',F15.6,T102,'N =',
     1        F15.6)
      WRITE(6,431) XL,U,XLU
  431 FORMAT(//'0', T21,'L =',F15.6, T63,'U =',F15.6,T102,'SMALL U =',
     1        F15.6)
```

```
      WRITE(6,434) QC,QBAR
  434 FORMAT(//'0',T21, 'QC =',F15.6, T63,'Q-BAR =',F15.6)
      WRITE(6,435) (I,W(I),I=1,12)
  435 FORMAT (//('0',T21,'W(',I2,') =',F15.6,T63,'W(',I2,') =',F15.6,
     1          T102,'W(',I2,') =',F15.6))
C
C
C   COMPUTING VALUES WITH CONTROL
C
C    COMPUTE NEW PI
      DO 1003 I=1,12
 1003 PI(I)=PI(I)-COC(I)
C
C   COMPUTE NEW I(I)
      CALL  IVALUE(XI,PI,XKTPRE,T,XT,V)
C
      DO 1004 I=1,12
C   COMPUTE NEW K(I)
      XKNEW(I) = (XKTPRE(I)+XI(I))/(1.+D7(I))
C   COMPUTE NEW E(I)
      E(I) = (XKNEW(I)/XK(I)) * E(I)
C   COMPUTE NEW V(I)
      V(I) = (XKNEW(I)/XK(I))*V(I)
C   COMPUTE NEW N(I)
      XN(I) = BETA(I)*V(I)/W(I)
C   COMPUTE NEW M(I)
      XM(I) = A3(I)*V(I)
C   COMPUTE NEW Q(I)
      IF (I-2) 800,801,800
  801 IF(XT.LT.6.0) GO TO 803
      Q(2) = -6.706 + 0.2978*V(2) + 5.758*XT
      GO TO 1004
  803 Q(2) = 37.414 + 0.2978*V(2) + 5.758*XT
      GO TO 1004
  800 Q(I) = A17(I) + B17(I)*V(I) + C17(I)*XT
 1004 CONTINUE
C
```

```
C   COMPUTE Y**, C*, Y(*), N-BAR*, N*, L*, U*, SMALL U*, QC*, Q-BAR*
                CALL NCCEM(XI,E,XM,G,V,XN,UN,YSTAR,XC,YREG,XNBAR,XNTOT,
     1                   XL,U,XLU,QC,QBAR)
C
C   WRITE THE NEW COMPLTEC VALLES
C
      WRITE(6,711)
  711 FORMAT ('1',14X,'(B) NEW VALUES COMPUTED WITH CGST CCNTROL FACTOR'
     1//)
      WRITE(6,441) (I,PI(I),I,XI(I),I = 1,12)
  441 FORMAT    ('0',T21,'PI*(',I2,') =',F15.6,T68,'I*(',I2,') =',F15.6)
      WRITE(6,443) (I,XKNEW(I),I,V(I),I = 1,12)
  443 FORMAT (//('0',T21,'K*(',I2,') =',F15.6,T68,'V*(',I2,') =',F15.6))
      WRITE(6,445) (I,XN(I),I,XM(I),I=1,12)
  445 FORMAT ('1',(T21,'N*(',I2,') =',F15.6,T68,'M*(',I2,') =',F15.6/))
      WRITE(6,447) (I,Q(I),I,E(I),I=1,12)
  447 FORMAT (//('0',T21,'Q*(',I2,') =',F15.6,T68,'E*(',I2,') =',F15.6))
      WRITE(6,448) YSTAR,XC,YREG
  448 FORMAT (//'1',T21,'(Y*)* =',F15.6,T68,'C* =',F15.6,T102,'(Y)* =',
     1          F15.6)
      WRITE(6,449) XNBAR,XNTCT,XL
  449 FORMAT (//'0',T21,'N-BAR* =',F15.6,T68,'N* =',F15.6,T102,'L* =',
     1          F15.6)
      WRITE(6,440) U,XLU,QC
  440 FORMAT (//'0',T21,'U* =',F15.6,T68,'SMALL U* =',F15.6,T102,'QC* ='
     1          F15.6)
      WRITE(6,398) QBAR
  398 FORMAT (//'0',T21,'Q-BAR* =',F15.6)
C
      T = T + INCRT
      XT = T
      IF (T - LAST)20C1,2001,101C
C
 1010 CONTINUE
      END
      SUBROUTINE  IVALUE(XI,PI,XKTPRE,T,XT,V)
C
C
C
C
C   PURPOSE: AT A GIVEN TIME T, TC CCMPUTE I(I) FCR I = 1,...,12
C
C
C
C    ** INPUT ** T    = YEAR FCR WHICH QUANTITIES ARE BEING COMPUTED, WITH
C                        T = 0  CENOTING 1954
C                        T = 1  CENCTING 1955
C                               ETC.
C             ** XT            =  REAL T
C
C
C                      FCR I = 1,...,12
C
C             **  PI(I) =  CAPITAL SHARE OF VALUE ADDEC OR
C                              PROFIT BY INDUSTRY I ($MILLION)
C
C             **  K(I)  =  CAPITAL STCCK OF INDUSTRY I ($MILLION) AT TIME T-1
C
C             **  V(I)  =  VALLE ADDEC BY INDUSTRY I ($MILLION)
C
C
      CONTINUE
C
C   ** OUTPUT **  I(I)  =  INVESTMENT OF INDUSTRY I ($MILLION)
C
C
C
C PROCEDURE:  STRAIGHTFCRWARC. COMPUTE ALL VALUES OF I(I) FOR
C                I = 1,...,12 AS SPECIFIED BY CONSAD
C
C
C
```

```
C
      INTEGER T
      DIMENSION XI(12),PI(12),XKTPRE(12),V(12)
C
    1 XI(1) = 73.845 + .261*PI(1) - .421*XKTPRE(1)
    2 IF (T-7)22,21,22
   21 XI(2) = 5.111 + 0.C648*PI(2) + .321*XT
      GO TO 3
   22 XI(2) = 1.250 + C.C648*PI(2) + .321*XT
    3 IF(XT.LT.8.C.OR.XT.GT.10.C) GO TO 31
      XI(3) = 19.599 + C.C983*PI(3) - 0.235*XKTPRE(3)
      GO TO 4
   31 XI(3) = 11.672 + 0.C983*PI(3) - 0.235*XKTPRE(3)
    4 XI(4) = 10.222 + C.110*PI(4) - 0.0394*XKTPRE(4)
    5 XI(5)=51.01 + .291*PI(5)-.236*XKTPRE(5)
    6 XI(6) = 174.52 + 0.C486*PI(6) - 1.424*XKTPRE(6)
    7 XI(7) = 146.13 + .347*PI(7) - .767*XKTPRE(7) + 9.788*XT
    8 XI(8) = -3.950 + C.164*PI(8)
    9 IF(XT.LT.4.C.OR.XT.GT.7.C) GO TO 91
      XI(9) = 34.998 + C.C829*PI(9) - 0.369*XKTPRE(9) + 1.317*XT
      GO TO 10
   91 XI(9) = 29.697 + 0.C829*PI(9) - 0.369*XKTPRE(9) + 1.317*XT
   10 IF(XT.EQ.8.C) GC TO 1C1
      XI(10) =  -.553 + C.C75C*PI(10) + 0.169*XT
      GO TO 11
  101 XI(10) = 3.944 + 0.C750*PI(10) + 0.169*XT
   11 XI(11) = 66.549 + .166*PI(11) - .476*XKTPRE(11)
   12 XI(12) = -.C919 + .C635*PI(12) + .685*XT
      RETURN
      END
      SLBROUTINE NCDEM(XI,E,XM,G,V,XN,UN,YSTAR,XC,YREG,XNBAR,XNTCT,
     1                 XL,U,XLU,QC,QBAR)
C
C
C
C   PURPOSE: TO COMPUTE THE VALUES OF THE VARIABLES LISTED UNDER OUTPUT
C
C     ** INPUT **  SUM    = FLNCTICN TO ADD THE ELEMENTS OF A
C                             CNE-DIMENSIONAL ARRAY CF LENGTH 12.
C
C                           FCR  I = 1,...,12
C
C                ** E(I)  =  EXPCRT BY INDUSTRY I ($MILLION)
C
C                ** M(I)  =  IMPCRT BY INCUSTRY I ($MILLION)
C
C                ** G    =  LOCAL GOVERNMENT EXPENDITURE ($MILLION)
C
C                ** V(I)  =  VALLE ADCED BY INDUSTRY I ($MILLION)
C
C                ** N(I)  =  EMPLCYMENT BY INDUSTRY I (1000)
C
C             ** UN      =  NATICNAL UNEMPLOYMENT RATE (PERCENTAGE)
C
      CONTINUE
C
C    **OUTPUT  **  Y*  =  REGICNAL EXPENDITURE ($MILLION)
C
C                **  C   =  CCNSLMPTICN ($MILLION)
C
C                **  Y   =  REGICNAL INCOME ($MILLION)
C
C                **  N-BAR  =  EMPLOYMENT BY INDUSTRIES CTHER THAN MANUFACTURING
C
C                **  N   =  TCTAL EMPLOYMENT (1000)
C
C                **  L   =  TCTAL LABCR FORCE (1000)
```

```
C
C               **  U    =  UNEMPLCYMENT (1000)
C
C               **  SMALL L  =  LCCAL EMPLOYMENT RATE (PERCENT)
C
C               **  QC   =  ELECTRIC POWER DEMAND FOR RESIDENTIAL USE
C
C               **  Q-BAR  =  ELECTRIC POWER DEMAND FCR NCN-MANUFACTURING
C                               INDUSTRIES (1000)
C
C
C  PROCEDURE: STRAIGHTFCRWARC. COMPUTE THE OUTPUT VARIABLES AS
C                 SPECIFIED BY CONSAD.
C
C
C
C
      INTEGER T
      DIMENSION XI(12),E(12),XM(12),V(12),XN(12)
C
      YSTAR = (287.524 + SUM(XI) + SUM(E) - SUM(XM) + G)/0.408
      XC = 287.524 + .592*YSTAR
      YREG = -3667.206 + 1.565*YSTAR
      XNBAR = 384.798 + .0821*(YREG - SUM(V))
      XNTOT = SUM(XN) + XNBAR
      XL = 68.01 + .9384*XNTCT + 5.366*UN
      U = XL - XNTOT
      XLU = (U*100.)/XL
      QC = -1548.94 + .9486*XC
      QBAR = 479.98 + .4552*(YREG-SUM(V))
      RETURN
      END
      FUNCTION SUM(ABC)
C
C
C   PURPOSE: TO SUM THE ELEMENTS IN A ONE-DIMENSIONAL ARRAY OF
C                 LENGTH 12
C
C   ** INPUT **  THE ARRAY THAT IS TO BE SUMMED
C
C   ** OUTPUT **  SUM  =  SUM OF THE ELEMENTS IN THE ARRAY
C
C   PROCEDURE: (1) SET C = 0.0
C
C              (2) DO LOOP OVER J; C = C + ABC(J), J = 1,12
C
C              (3) SET SUM = C
C
C
      DIMENSION ABC(12)
      C = 0.0
      DO 1 J =1,12
    1 C = C + ABC(J)
      SUM = C
      RETURN
      END
```

APPENDIX B

RAPA DEMONSTRATION

The RAPA demonstration is a preliminary example of a regional air pollution analysis, using all of the individual models within the RAPA program. The analysis starts with 1) a display of existing St. Louis air quality, proceeds to 2) an evaluation of the air pollution control cost-effectiveness values associated with each of the major St. Louis industries, and concludes with 3) an estimate of the air quality and economic impacts resulting from the application of selected air pollution abatement strategies.

The demonstration test cases for each of the models in the RAPA program are structured around estimated control cost, emission inventory, and meteorological information for the St. Louis region.

As a result of this input information, there is a great deal of data produced in a single run of the RAPA program. However, the net result of the atmospheric diffusion processes and the control cost-effectiveness values is a relatively small number of "figures-of-merit", which provide a basis for abatement strategy evaluation. These figures-of-merit are of primary interest to the regional planner, since they provide estimates of control cost, emission rate reductions, and the cost-effectiveness of each candidate strategy. Because of their importance and the fact that most program users will want to look at these data first, they have been abstracted from the Abatement Strategy and Regional Econometric Models for the following Tables, B-1 and B-2. Further details and graphical displays can be obtained by studying the outputs of the individual models. (The output formats are still being refined. Many of the format features planned for the near future have been incorporated by hand in this report.)

TABLE B-1 ABATEMENT STRATEGY SUMMARY

STRATEGY		EXISTING REGIONAL EMISSIONS (Tons/Day)	NEW REGIONAL EMISSIONS (Tons/Day)	REGIONAL CONTROL COST ($ Millions)	REGIONAL EMISSION REDUCTION (%)	EMISSION CONTROL EFFECTIVENESS ($/Ton)	EXISTING POLLUTANT CONCENTRATION* (μ G/M^3)	NEW POLLUTANT CONCENTRATION* (μ G/M^3)	POLLUTANT CONTROL EFFECTIVENESS ($ Millions/μG/M^3)
NO	TYPE								
1	1% SULFUR CONTENT LIMITATION (SOx)	1696.13	838.15	10.536	42.98	12,281	300	215.45	0.11
	MAXIMUM CONTROL TECHNOLOGY (SOx)	1696.13	271.20	52.133	83.97	36,824		179.45	0.43
3	PROCESS WEIGHT LIMITATION (Particulates)	563.24	447.86	1.216	20.48	10,531	184.67	152.78	0.38
4	COMBUSTION CAPACITY LIMITATION (Particulates)	563.24	350.15	2.061	37.83	9,671		121.99	0.23
5	MAXIMUM CONTROL TECHNOLOGY (Particulates)	563.24	108.20	53.672	80.78	117,947		54.99	0.41

*Arithmetic mean ground level concentration at the maximum receptor.

TABLE B-2 REGIONAL ECONOMY SUMMARY

STRATEGY	ANNUAL COST ($ Million)	VALUE ADDED	IMPORT	EMPLOYMENT	CAPITAL STOCK	INVESTMENT	CAPITAL SHARE OF VALUE ADDED
1% SULFUR LIMITATION (SOx)	10.536	-0.04%	-0.03%	-0.06%	+0.03%	-0.46%	-0.54%
PROCESS WEIGHT LIMITATION (Particulates)	1.216	-0.006%	-0.007%	-0.006%	+0.07%	-0.09%	-0.06%

(All numbers are a percentage change in the 1966 St. Louis economy as a result of control costs. The individual parameters represent aggregated values over the SIC codes identified in Chapter 7.)

B.1 ATMOSPHERIC DIFFUSION MODEL

The St. Louis emission inventory, read from the data file by the diffusion model, is repeated in an abbreviated form as an output on pages B-12 and B-16.

The conversion of the selected air quality standard is summarized on page B-20. In each case, two alternate forms (Standard = 1 and Standard = 2) are provided as input and the program selects the one with the minimum arithmetic mean.

The results of the calibration procedure are described in the output on page B-21. The station number and X, Y coordinates in kilometers are given in the first three columns, and the arithmetic mean concentrations are listed in the next six columns, with measured values on the bottom line for each station entry. The arithmetic means are listed in the following order: 1) SO_x (PPM), summer; 2) particulates (G/M^3), summer; 3) SO_x, winter; 4) particulates, winter; 5) SO_x, annual; and 6) particulates, annual.

The next six lines of output describe the regression lines, with one regression line for each of the six pollutant-season combinations, in the same order as the arithmetic mean output described above. Only those regression coefficients for which a y-intercept, slope, etc., are printed out were subsequently used to adjust the theoretical values of the arithmetic mean ground-level concentrations. Whenever the correlation coefficient falls below a certain threshold value, as it did for the SO_x and particulate winter regression lines, the message "POOR CORRELATION" is printed out and the resulting coefficients are discarded.

The locations of the 12 measuring stations used in the calibration, as well as the receptor grid numbering system, are presented in Figure B-1. The receptors which were selected for the statistical output beginning on page B-26 are also shown here. These twelve receptors consist of seven of the measuring station locations and five of the receptor grid points, selected to give an east-west cross section of the St. Louis region.

The contribution of each source in the St. Louis region to the five receptors with maximum concentrations is listed in the output beginning on page B-32. A display of this type makes identification of the major sources in the region much easier.

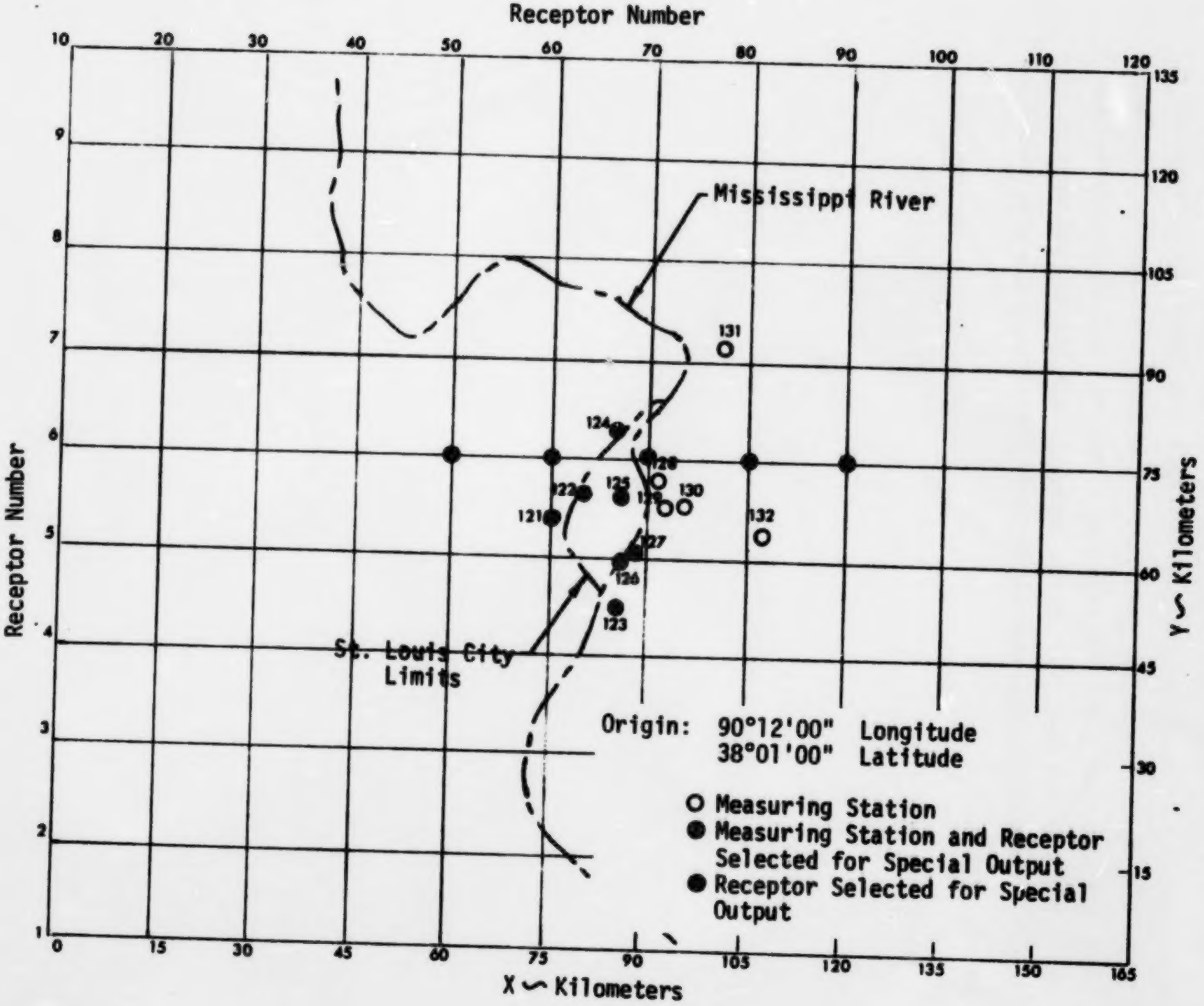

Receptor Number
10
20
30
40
50
60
70
80
90
100
110
120
Receptor Number
1
2
3
4
5
6
7
8
9
10
Y ∽ Kilometers
135
120
105
90
75
60
45
30
15
X ∽ Kilometers
0
15
30
45
60
75
90
105
120
135
150
165
Mississippi River
St. Louis City Limits
121
122
123
124
125
126
127
128
129
130
131
132
Origin: 90°12'00" Longitude
38°01'00" Latitude
○ Measuring Station
● Measuring Station and Receptor Selected for Special Output
● Receptor Selected for Special Output

FIGURE B.1. - MEASURING STATION AND RECEPTOR LOCATIONS

Isopleths of average ground-level concentrations for annual SO_x and particulate pollutants are plotted using the SYMAP program. These are presented for SO_x and particulates on pages B-40 and B-41, respectively. In the SO_x plot, the region just inside the area described by the L's exceeds the value of 0.015 PPM selected as the air quality standard (page B-40). For particulates, the region where the air quality standard of 40 $\mu G/M^3$ (page B-41) is exceeded is slightly larger than the area described by the crosses.

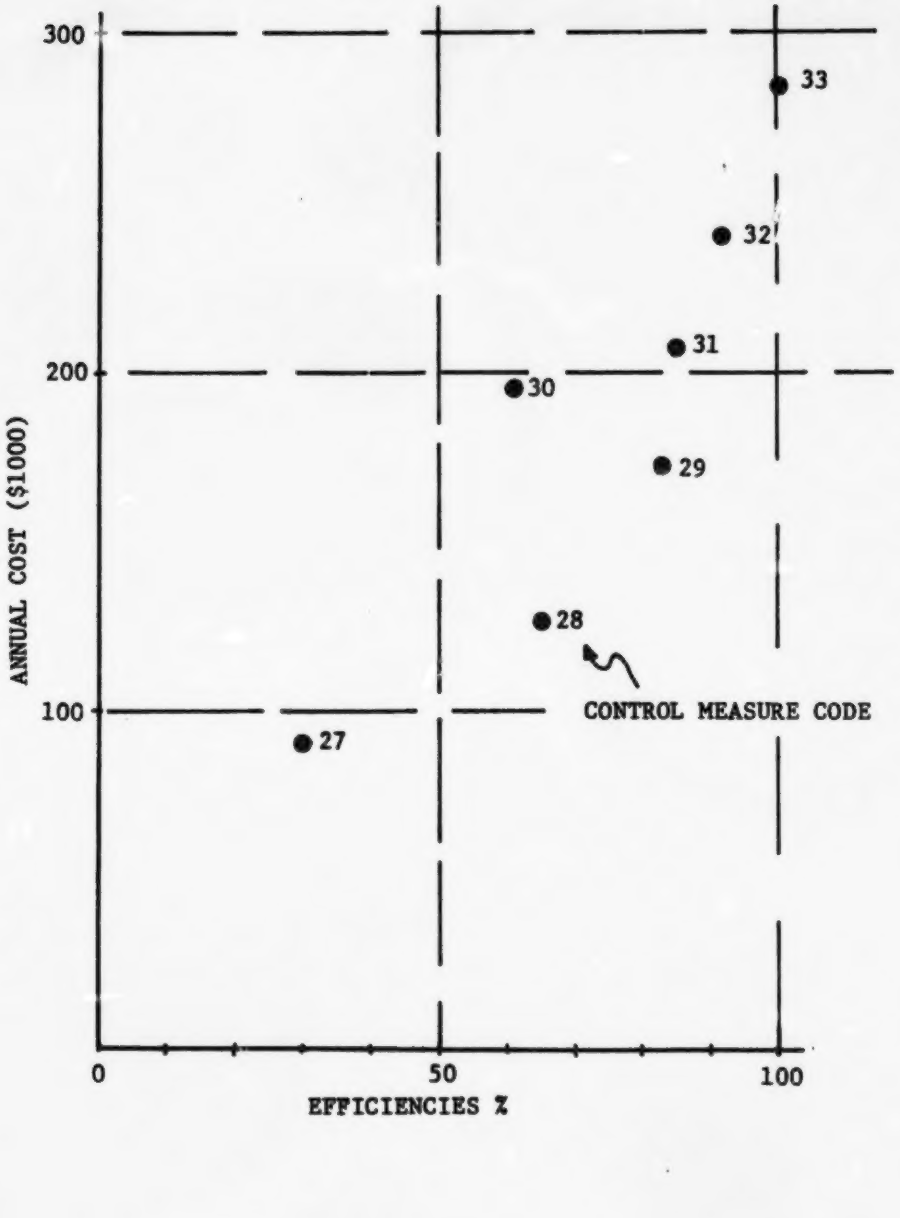
B.2 CONTROL COST-EFFECTIVENESS MODEL

The estimated characteristics of various control devices (e.g., precipitators, cyclones) and control measures (fuel substitution, fuel switching) are listed on pages B-42 through B-76, according to the sources to which they apply. This output is used in a separate analysis of industrial air pollution control cost-effectiveness, as shown in the examples of Figure B-2, or as an input to the Abatement Strategy Model.

FIGURE B-2

CONTROL COST-EFFECTIVENESS SOx REDUCTION

SIC = 2010 SITE 920



B.3 ABATEMENT STRATEGY MODEL

Five abatement strategies were simulated with this model to measure the control cost and air quality impacts of air pollution control. For SO_x control, a fuel sulfur content limitation and a maximum control technology strategy were simulated on pages B-77 through B-104. For particulates, a process weight regulation, combustion capacity regulation, and a maximum control technology strategy were simulated on pages B-86, B-95 and B-113, respectively.

In each simulation the output consisted of:

(a) a summary of the regional impact of the strategy, in terms of sources controlled, control measures selected, control measure cost and efficiency, and emission reductions,

(b) new ground-level concentrations, amount reduced, and amount in excess of air quality standard for each receptor in the region,

(c) statistical air quality data after control for twelve selected receptors in the region, and

(d) a SYMAP plot of ground-level concentration contours after control.

The results of these strategies were summarized earlier in Table B-1.

B.4 OPTIMAL CONTROL STRATEGY

In this demonstration an optimization process is used to obtain a least-cost, or optimal, control strategy which meets the annual average goal recommended by the St. Louis Interstate Air Pollution Study for ground-level concentration of particulate matter. This goal is expressed in terms of an annual ground-level concentration average of 75 micrograms per cubic meter of air.

The required data on control cost and control efficiency are made available through the operation of the Control Cost-Effectivess Model, and pollutant transfer coefficients between sources and receptors are made available through the operation of the Atmospheric Diffusion Model. For this test case, 23 of the largest particulate pollutant sources in the St. Louis Air Quality Control Region were selected for possible emission reduction.

The particulate ground-level concentration resulting from these sources is considered as the only controllable element in the demonstration. Ground-level concentration at 25 receptor locations, centrally located in the region, is computed before and after application of the optimal control model. After the control is applied, the ground-level concentration at the 25 receptor locations should be at or below the recommended level. The model then provides the total cost and required emission reductions for successfully meeting the goal.

Thus, the demonstration includes 23 independent variables (i.e., the degree of emission reduction at each source), 25 primary constraints (i.e., the degree of reduction of ground level-concentration required at each receptor to meet the stated standard), and 23 constraints representing the maximum possible reduction with current particulate control technology at each source. Page B-123illustrates a sample output of the optimal control strategy which is described in detail in Chapter 6. (The results of the optimal control model were obtained in an operation separate from the RAPA program, due to programming restrictions. Therefore, the actual values of this strategy do not reflect the same level of accuracy as the remaining strategies. (The optimal control strategy is in the process of being integrated into the RAPA program).

B.5 REGIONAL ECONOMETRIC MODEL

The resulting control cost data from the Abatement Strategy Model are used as an input to the Regional Econometric Model. The simulation of the St. Louis economy in pages B-124through B-142is demonstrated for each of the five strategies discussed in Section B.3. A summary of this information is listed in Table B-2. The initial "before control" conditions in St. Louis are shown on pages B-125through B-127 The industry identification in terms of the two-digit Standard Industrial Classification (SIC) codes for the simulated industries is discussed in Chapter 7.

SOURCE DATA

ST. LOUIS....TEST CASE-B

SOURCE NUMBER	SOURCE LOCATION		SOURCE AREA
	HORIZONTAL KILOMETERS	VERTICAL KILOMETERS	SQUARE KILOMETERS
1	85.000	70.600	0.0 A POINT SOURCE
2	90.300	69.000	0.0 A POINT SOURCE
3	81.200	67.000	0.0 A POINT SOURCE
4	80.300	65.800	0.0 A POINT SOURCE
5	97.800	77.900	0.0 A POINT SOURCE
6	87.200	73.200	0.0 A POINT SOURCE
7	88.100	68.300	0.0 A POINT SOURCE
8	87.600	69.900	0.0 A POINT SOURCE
9	84.000	67.000	0.0 A POINT SOURCE
10	88.900	66.900	0.0 A POINT SOURCE
11	86.600	62.300	0.0 A POINT SOURCE
12	85.800	63.800	0.0 A POINT SOURCE
13	89.400	95.900	0.0 A POINT SOURCE
14	82.400	68.400	0.0 A POINT SOURCE
15	90.500	75.800	0.0 A POINT SOURCE
16	85.700	63.300	0.0 A POINT SOURCE
17	85.300	63.400	0.0 A POINT SOURCE
18	104.700	55.300	0.0 A POINT SOURCE
19	93.700	93.800	0.0 A POINT SOURCE
20	93.700	93.800	0.0 A POINT SOURCE
21	88.000	71.000	0.0 A POINT SOURCE
22	86.800	64.600	0.0 A POINT SOURCE
23	81.700	57.900	0.0 A POINT SOURCE
24	98.400	69.700	0.0 A POINT SOURCE
25	88.900	64.500	0.0 A POINT SOURCE
26	88.300	63.800	0.0 A POINT SOURCE
27	88.300	63.800	0.0 A POINT SOURCE
28	80.800	57.000	0.0 A POINT SOURCE
29	80.800	57.000	0.0 A POINT SOURCE
30	71.500	31.700	0.0 A POINT SOURCE
31	71.500	31.700	0.0 A POINT SOURCE
32	90.300	70.000	0.0 A POINT SOURCE
33	88.600	63.200	0.0 A POINT SOURCE
34	88.600	63.200	0.0 A POINT SOURCE
35	85.200	74.400	0.0 A POINT SOURCE
36	62.200	58.000	0.0 A POINT SOURCE
37	97.700	91.300	0.0 A POINT SOURCE
38	97.300	90.500	0.0 A POINT SOURCE
39	97.100	89.300	0.0 A POINT SOURCE
40	90.200	63.700	0.0 A POINT SOURCE
41	90.200	63.700	0.0 A POINT SOURCE
42	68.000	54.300	0.0 A POINT SOURCE
43	91.100	65.400	0.0 A POINT SOURCE
44	91.500	65.000	0.0 A POINT SOURCE
45	71.800	21.700	0.0 A POINT SOURCE

SOURCE DATA

ST. LOUIS....TEST CASE-B

CONTINUED

SOURCE NUMBER	SOURCE LOCATION		SOURCE AREA	
	HORIZONTAL KILOMETERS	VERTICAL KILOMETERS	SQUARE KILOMETERS	
46	85.200	78.900	0.0	A POINT SOURCE
47	75.800	56.200	0.0	A POINT SOURCE
48	68.700	76.200	0.0	A POINT SOURCE
49	80.000	66.800	0.0	A POINT SOURCE
50	83.100	91.200	0.0	A POINT SOURCE
51	83.000	90.800	0.0	A POINT SOURCE
52	75.300	56.100	0.0	A POINT SOURCE
53	91.500	94.900	0.0	A POINT SOURCE
54	91.500	94.900	0.0	A POINT SOURCE
55	92.100	74.200	0.0	A POINT SOURCE
56	92.100	74.200	0.0	A POINT SOURCE
57	92.100	74.200	0.0	A POINT SOURCE
58	92.100	74.200	0.0	A POINT SOURCE
59	92.100	74.200	0.0	A POINT SOURCE
60	90.300	75.700	0.0	A POINT SOURCE
61	90.300	75.700	0.0	A POINT SOURCE
62	89.600	73.900	0.0	A POINT SOURCE
63	89.600	73.900	0.0	A POINT SOURCE
64	89.800	74.500	0.0	A POINT SOURCE
65	71.800	26.400	0.0	A POINT SOURCE
66	71.800	26.400	0.0	A POINT SOURCE
67	71.800	26.400	0.0	A POINT SOURCE
68	82.000	73.300	0.0	A POINT SOURCE
69	65.100	54.500	0.0	A POINT SOURCE
70	84.400	75.800	0.0	A POINT SOURCE
71	94.900	94.800	0.0	A POINT SOURCE
72	88.700	71.200	0.0	A POINT SOURCE
73	88.300	68.100	0.0	A POINT SOURCE
74	85.200	64.400	0.0	A POINT SOURCE
75	75.200	99.000	0.0	A POINT SOURCE
76	130.000	84.500	0.0	A POINT SOURCE
77	76.900	41.800	0.0	A POINT SOURCE
78	86.800	72.000	0.0	A POINT SOURCE
79	84.700	61.700	0.0	A POINT SOURCE
80	81.700	74.000	0.0	A POINT SOURCE
81	82.000	69.600	0.0	A POINT SOURCE
82	85.600	65.800	0.0	A POINT SOURCE
83	80.100	64.800	0.0	A POINT SOURCE
84	80.200	53.500	0.0	A POINT SOURCE
85	92.200	95.500	0.0	A POINT SOURCE
86	12.000	60.500	707.40	
87	12.000	31.000	707.40	
88	89.900	49.400	44.20	
89	101.500	100.500	44.20	
90	95.700	93.200	44.20	

SOURCE DATA

ST. LOUIS....TEST CASE-B

CONTINUED

SOURCE NUMBER	SOURCE LOCATION		SOURCE AREA
	HORIZONTAL KILOMETERS	VERTICAL KILOMETERS	SQUARE KILOMETERS
91	75.400	97.000	176.80
92	84.100	93.300	44.20
93	72.500	86.000	44.20
94	78.300	86.000	44.20
95	84.100	86.000	44.20
96	89.900	86.000	44.20
97	82.700	80.500	11.10
98	85.600	80.500	11.10
99	88.500	80.500	11.10
100	91.400	80.500	11.10
101	34.800	89.700	707.40
102	58.000	89.700	707.40
103	72.500	78.700	44.20
104	78.300	78.700	44.20
105	82.700	76.900	11.10
106	85.600	76.900	11.10
107	88.500	76.900	11.10
108	91.400	76.900	11.10
109	98.600	82.400	176.80
110	127.600	97.000	707.40
111	82.700	73.200	11.10
112	85.600	73.200	11.10
113	85.600	73.200	11.10
114	91.400	73.200	11.10
115	72.500	71.400	77.20
116	78.300	71.400	44.20
117	82.700	69.500	11.10
118	85.600	69.500	11.10
119	88.500	69.500	11.10
120	91.400	69.500	11.10
121	82.700	65.900	11.10
122	82.700	65.900	11.10
123	88.500	65.900	11.10
124	91.400	65.900	11.10
125	72.500	64.100	44.20
126	78.300	64.100	44.20
127	82.700	62.200	11.10
128	85.600	62.200	11.10
129	88.500	62.200	11.10
130	91.400	62.200	11.10
131	34.800	60.400	707.40
132	49.300	53.100	176.80
133	72.500	49.400	44.20
134	84.100	49.400	44.20
135	98.600	53.100	176.80

SOURCE DATA

ST. LOUIS....TEST CASE-B

CONTINUED

SOURCE NUMBER	SOURCE LOCATION		SOURCE AREA
	HORIZONTAL KILOMETERS	VERTICAL KILOMETERS	SQUARE KILOMETERS
136	127.600	60.400	707.40
137	34.800	31.100	707.40
138	58.000	31.100	707.40
139	81.200	31.100	707.40
140	104.400	31.100	707.40
141	127.600	31.100	707.40
142	84.100	100.700	44.20
143	89.900	100.700	44.20
144	95.700	100.700	44.20
145	88.500	95.200	11.10
146	91.400	95.200	11.10
147	88.500	91.200	11.10
148	91.400	91.500	11.10
149	101.500	93.300	44.20
150	110.200	97.000	176.80
151	52.200	67.700	176.80
152	63.800	67.700	176.80
153	95.700	71.400	44.20
154	101.500	71.400	44.20
155	84.100	56.700	44.20
156	95.700	64.100	44.20
157	101.500	64.100	44.20
158	104.400	67.700	176.80
159	63.800	53.100	176.80
160	72.500	56.700	44.20
161	78.300	56.700	44.20
162	89.900	56.700	44.20
163	78.300	49.400	44.20
164	110.200	53.100	176.80

SOURCE DATA

ST. LOUIS....TEST CASE-B

SOURCE CONCENTRATION (TONS/DAY)

SOURCE NUMBER	SUMMER			WINTER			ANNUAL		
	SOX	CO	PART	SOX	CO	PART	SOX	CO	PART
1	1.84	0.0	1.64	2.90	0.0	2.60	2.30	0.0	2.05
	9.05	0.0	11.56	9.05	0.0	11.56	9.05	0.0	11.56
	4.87	0.0	4.39	7.69	0.0	6.87	6.08	0.0	5.44
4	109.00	0.0	1.39	1.71	0.0	2.19	1.35	0.0	1.73
	0.0	0.0	2.98	0.0	0.0	2.98	0.0	0.0	2.98
	0.0	0.0	2.28	0.0	0.0	2.28	0.0	0.0	2.28
7	0.0	0.0	1.49	0.0	0.0	1.49	0.0	0.0	1.49
	0.0	0.0	2.04	0.0	0.0	2.04	0.0	0.0	2.04
	0.0	0.0	2.48	0.0	0.0	2.48	0.0	0.0	2.48
10	0.0	0.0	2.48	0.0	0.0	2.48	0.0	0.0	2.48
	0.0	0.0	4.96	0.0	0.0	4.96	0.0	0.0	4.96
	0.0	0.0	1.49	0.0	0.0	1.49	0.0	0.0	1.49
13	0.0	0.0	3.48	0.0	0.0	3.48	0.0	0.0	3.48
	0.0	0.0	3.78	0.0	0.0	3.78	0.0	0.0	3.78
	18.79	0.0	10.80	18.79	0.0	10.80	18.79	0.0	10.80
16	1.26	0.0	1.61	1.99	0.0	2.54	1.58	0.0	2.01
	14.32	0.0	1.83	22.62	0.0	2.89	17.90	0.0	2.29
	3.17	0.0	4.00	3.17	0.0	4.00	3.17	0.0	4.00
19	10.23	0.0	1.98	10.23	0.0	1.98	10.23	0.0	1.98
	5.98	0.0	0.0	5.98	0.0	0.0	5.98	0.0	0.0
	21.39	0.0	4.09	33.79	0.0	6.47	26.74	0.0	5.12
22	2.11	0.0	1.89	3.33	0.0	2.98	2.63	0.0	2.36
	6.25	0.0	4.79	9.88	0.0	7.56	7.82	0.0	5.99
	12.00	0.0	1.90	12.00	0.0	1.90	12.00	0.0	1.90
25	11.00	0.0	0.17	11.00	0.0	0.17	11.00	0.0	0.17
	31.69	0.0	19.26	31.69	0.0	19.26	31.69	0.0	19.26
	19.10	0.0	0.26	19.10	0.0	0.26	19.10	0.0	0.26
28	20.36	0.0	3.90	20.36	0.0	3.90	20.36	0.0	3.90
	23.70	0.0	0.21	23.70	0.0	0.21	23.70	0.0	0.21
	0.0	0.0	21.90	0.0	0.0	21.90	0.0	0.0	21.90
31	0.0	0.0	48.50	0.0	0.0	48.50	0.0	0.0	48.50
	0.0	0.0	8.00	0.0	0.0	8.00	0.0	0.0	8.00
	2.12	0.0	4.26	2.12	0.0	4.26	2.12	0.0	4.26
34	0.0	0.0	1.45	0.0	0.0	1.45	0.0	0.0	1.45
	1.91	0.0	0.61	3.01	0.0	0.96	2.38	0.0	0.76
	0.0	0.0	2.40	0.0	0.0	2.40	0.0	0.0	2.40
37	0.0	206.00	0.15	0.0	206.00	0.15	0.0	206.00	0.15
	0.0	521.00	0.12	0.0	521.00	0.12	0.0	521.00	0.12
	0.0	82.40	0.02	0.0	82.40	0.02	0.0	82.40	0.02
40	0.87	0.0	0.07	0.87	0.0	0.07	0.87	0.0	0.07
	0.0	89.30	0.0	0.0	89.30	0.0	0.0	89.30	0.0
	0.0	0.0	1.95	0.0	0.0	0.0	0.0	0.0	0.97
43	4.99	0.0	6.96	7.90	0.0	10.44	6.95	0.0	8.70
	0.0	0.0	3.50	0.0	0.0	3.50	0.0	0.0	3.50
	2.93	0.0	0.37	2.93	0.0	0.37	2.93	0.0	0.37

SOURCE DATA

ST. LOUIS....TEST CASE-B

CONTINUED

SOURCE CONCENTRATION (TONS/DAY)

SOURCE NUMBER	SUMMER			WINTER			ANNUAL		
	SOX	CO	PART	SOX	CO	PART	SOX	CO	PART
46	0.0	0.0	2.79	0.0	0.0	2.79	0.0	0.0	2.79
	0.0	0.0	5.80	0.0	0.0	5.80	0.0	0.0	5.80
	0.0	0.0	3.04	0.0	0.0	3.04	0.0	0.0	3.04
49	0.0	0.0	1.20	0.0	0.0	1.20	0.0	0.0	1.20
	0.0	0.0	19.18	0.0	0.0	19.18	0.0	0.0	19.18
	0.0	0.0	8.22	0.0	0.0	8.22	0.0	0.0	8.22
52	0.0	0.0	13.70	0.0	0.0	13.70	0.0	0.0	13.70
	1.53	0.0	2.04	1.53	0.0	2.04	1.53	0.0	2.04
	0.0	0.0	0.50	0.0	0.0	0.50	0.0	0.0	0.50
55	6.02	0.0	1.10	6.02	0.0	1.10	6.02	0.0	1.10
	0.0	0.0	1.00	0.0	0.0	1.00	0.0	0.0	1.00
	0.0	0.0	0.74	0.0	0.0	0.74	0.0	0.0	0.74
58	0.23	0.0	0.27	0.23	0.0	0.27	0.23	0.0	0.27
	0.25	0.0	2.84	0.25	0.0	2.84	0.25	0.0	2.84
	5.14	0.0	6.90	5.14	0.0	6.90	5.14	0.0	6.90
61	0.0	0.0	1.10	0.0	0.0	1.10	0.0	0.0	1.10
	6.19	0.0	0.59	6.19	0.0	0.59	6.19	0.0	0.59
	0.0	0.0	0.60	0.0	0.0	0.60	0.0	0.0	0.60
64	0.92	0.0	1.01	0.92	0.0	1.01	0.92	0.0	1.01
	203.00	0.0	0.31	203.00	0.0	0.31	203.00	0.0	0.31
	1.32	0.0	0.26	1.32	0.0	0.26	1.32	0.0	0.26
67	28.20	0.0	0.02	28.20	0.0	0.02	28.20	0.0	0.02
	4.53	0.0	0.86	7.16	0.0	1.36	5.66	0.0	1.08
	0.0	0.0	0.0	11.03	0.0	14.04	4.74	0.0	6.05
70	1.28	0.0	0.98	2.02	0.0	1.54	1.60	0.0	1.22
	187.50	1.00	88.62	353.10	1.50	152.00	248.80	1.10	112.10
	116.95	0.0	15.32	116.95	0.0	15.32	116.95	0.0	15.32
73	23.18	0.0	2.95	79.02	0.0	10.07	39.02	0.0	4.98
	31.94	0.0	4.03	41.74	0.0	5.27	32.14	0.0	4.06
	192.08	0.0	1.97	192.08	0.0	1.97	192.08	0.0	1.97
76	3.59	0.0	4.58	3.59	0.0	4.58	3.59	0.0	4.58
	419.00	1.85	13.45	382.40	1.70	12.25	377.20	1.70	12.09
	0.30	0.15	2.55	0.30	0.15	2.55	0.30	0.15	2.55
79	0.30	0.15	2.55	0.30	0.15	2.55	0.30	0.15	2.55
	0.0	0.0	0.0	3.90	0.0	0.50	1.68	0.0	0.21
	0.0	0.0	0.0	7.65	0.0	6.84	3.29	0.0	2.94
82	0.0	0.0	0.0	5.17	0.0	6.60	2.20	0.0	2.84
	0.0	0.0	0.0	7.32	0.0	9.34	3.15	0.0	4.02
	0.0	0.0	0.0	5.80	0.0	7.40	2.50	0.0	3.19
85	0.0	0.0	0.0	3.29	0.0	0.63	1.42	0.0	0.27
	0.01	0.0	0.04	0.01	0.0	0.04	0.01	0.0	0.04
	0.01	0.0	0.04	0.01	0.0	0.04	0.01	0.0	0.04
88	0.01	0.0	0.03	0.06	0.0	0.27	0.77	0.0	0.13
	0.03	0.0	0.08	2.88	0.0	1.17	1.28	0.0	0.50
	0.43	0.0	0.47	5.58	0.0	2.61	2.80	0.0	1.41

S O U R C E   D A T A

ST. LOUIS....TEST CASE-B

CONTINUED
SOURCE CONCENTRATION (TONS/DAY)

Source Number	SUMMER SOX	SUMMER CO	SUMMER PART	WINTER SOX	WINTER CO	WINTER PART	ANNUAL SOX	ANNUAL CO	ANNUAL PAR
91	0.03	0.0	0.16	0.33	0.0	0.31	0.21	0.0	0.23
	0.02	0.0	0.17	0.47	0.0	0.33	0.18	0.0	0.24
	0.04	0.0	0.05	1.03	0.0	0.42	0.48	0.0	0.21
94	0.46	0.0	0.20	1.22	0.0	1.03	0.77	0.0	0.23
	0.01	0.0	0.06	0.45	0.0	0.21	0.20	0.0	0.13
	0.02	0.0	0.04	0.46	0.0	0.19	0.21	0.0	0.10
97	0.01	0.0	0.03	0.51	0.0	0.24	0.23	0.0	0.13
	0.03	0.0	0.04	0.28	0.0	0.14	0.14	0.0	0.09
	0.01	0.0	0.10	0.14	0.0	0.15	0.07	0.0	0.12
100	0.01	0.0	0.07	0.01	0.0	0.07	0.01	0.0	0.07
	0.03	0.0	0.13	0.98	0.0	0.49	0.44	0.0	0.28
	0.09	0.0	1.39	1.87	0.0	2.02	0.88	0.0	1.67
103	0.05	0.0	0.49	5.07	0.0	2.47	2.29	0.0	1.38
	0.06	0.0	0.05	2.41	0.0	1.09	1.12	0.0	0.52
	0.05	0.0	0.18	2.27	0.0	1.06	1.43	0.0	0.73
106	0.55	0.0	0.38	1.05	0.0	0.57	0.77	0.0	0.46
	0.01	0.0	0.07	0.68	0.0	0.33	0.67	0.0	0.33
	0.23	0.0	0.40	3.74	0.0	1.81	1.78	0.0	1.02
109	0.03	0.0	0.15	1.91	0.0	0.88	0.85	0.0	0.48
	0.02	0.0	0.07	2.42	0.0	1.01	1.07	0.0	0.49
	1.04	0.0	2.50	7.04	0.0	4.47	3.74	0.0	3.38
112	0.22	0.0	0.50	2.56	0.0	1.72	1.17	0.0	0.84
	0.22	0.0	0.50	2.56	0.0	1.72	1.17	0.0	0.84
	0.96	0.0	2.20	5.60	0.0	4.03	3.00	0.0	3.02
115	0.35	0.0	1.08	5.99	0.0	3.35	2.82	0.0	2.11
	0.18	0.0	0.17	42.56	0.0	17.20	19.28	0.0	7.68
	0.07	0.0	0.17	26.32	0.0	10.73	11.61	0.0	4.83
118	1.18	0.0	0.56	16.96	0.0	6.41	6.95	0.0	3.15
	0.43	0.0	2.20	8.60	0.0	5.30	4.35	0.0	3.75
	0.44	0.0	2.18	1.40	0.0	2.56	0.86	0.0	2.35
121	0.29	0.0	0.74	19.20	0.0	7.76	8.66	0.0	3.84
	0.29	0.0	0.74	19.20	0.0	7.76	8.66	0.0	3.84
	0.03	0.0	0.18	6.17	0.0	2.43	2.76	0.0	1.20
124	0.01	0.0	0.07	5.12	0.0	2.10	2.26	0.0	0.96
	0.08	0.0	0.40	5.48	0.0	2.59	2.89	0.0	1.97
	0.11	0.0	2.72	11.92	0.0	7.46	5.31	0.0	4.90
127	0.76	0.0	0.19	6.14	0.0	2.30	2.83	0.0	1.16
	0.05	0.0	1.05	11.65	0.0	5.57	5.15	0.0	3.05
	0.13	0.0	0.24	2.60	0.0	1.23	1.21	0.0	0.67
130	0.02	0.0	0.07	0.50	0.0	0.25	0.23	0.0	0.15
	0.06	0.0	3.46	3.19	0.0	1.88	1.90	0.0	1.85
	0.15	0.0	1.09	1.13	0.0	1.44	0.58	0.0	0.34
133	0.05	0.0	0.16	1.02	0.0	0.50	0.48	0.0	0.18
	0.01	0.0	0.05	0.30	0.0	0.16	0.14	0.0	0.11
	0.03	0.0	0.33	4.96	0.0	2.26	2.20	0.0	2.89

SOURCE DATA

ST. LOUIS....TEST CASE-B

CONTINUED
SOURCE CONCENTRATION (TONS/DAY)

SOURCE NUMBER	SUMMER SOX	SUMMER CO	SUMMER PART	WINTER SOX	WINTER CO	WINTER PART	ANNUAL SOX	ANNUAL CO	ANNUAL PART
136	0.03	0.0	0.07	3.22	0.0	1.28	1.43	0.0	0.65
	0.12	0.0	0.11	3.05	0.0	1.18	1.41	0.0	0.69
	0.07	0.0	0.20	2.32	0.0	1.01	1.16	0.0	0.58
139	0.05	0.0	0.22	2.22	0.0	1.06	1.00	0.0	0.39
	0.01	0.0	0.02	0.91	0.0	0.40	0.43	0.0	0.24
	0.03	0.0	0.07	1.54	0.0	0.61	0.70	0.0	0.24
142	0.0	0.0	0.0	0.11	0.0	0.04	0.05	0.0	0.15
	0.01	0.0	0.07	0.91	0.0	0.43	0.41	0.0	0.24
	0.02	0.0	0.08	3.03	0.0	1.27	1.34	0.0	0.69
145	0.01	0.0	0.14	1.34	0.0	0.66	0.68	0.0	0.80
	0.09	0.0	0.58	1.89	0.0	1.29	0.88	0.0	0.28
	0.01	0.0	0.05	0.27	0.0	0.14	0.13	0.0	0.07
148	0.02	0.0	0.03	0.20	0.0	0.19	0.07	0.0	0.22
	0.04	0.0	0.19	3.72	0.0	1.65	1.66	0.0	0.80
	0.02	0.0	0.14	0.71	0.0	0.41	0.32	0.0	0.17
151	0.02	0.0	0.03	1.10	0.0	0.44	0.42	0.0	0.22
	0.06	0.0	0.04	1.85	0.0	0.63	0.84	0.0	0.57
	0.05	0.0	0.32	12.71	0.0	5.36	5.62	0.0	2.49
154	0.31	0.0	0.12	3.82	0.0	1.50	1.57	0.0	2.90
	0.07	0.0	1.11	7.01	0.0	4.91	3.12	0.0	7.58
	0.11	0.0	0.32	18.34	0.0	7.55	8.12	0.0	3.43
157	0.01	0.0	0.07	1.10	0.0	0.49	0.49	0.0	0.26
	0.03	0.0	0.07	5.06	0.0	2.04	2.24	0.0	0.92
	0.04	0.0	0.10	1.36	0.0	0.55	0.62	0.0	0.26
160	0.02	0.0	0.04	0.97	0.0	0.36	0.44	0.0	0.12
	0.07	0.0	0.17	0.89	0.0	0.42	0.43	0.0	0.37
	0.01	0.0	0.07	0.76	0.0	1.94	0.33	0.0	0.68
163	0.02	0.0	0.04	0.77	0.0	0.31	0.35	0.0	0.16
	1.23	0.0	0.57	10.29	0.0	4.16	5.21	0.0	2.09

CONVERSION OF AIR QUALITY STANDARDS TO ARITHMETIC MEANS

```
SEASON = 3
POLLUTANT = 1
STANDARD = 1

     AVTM = 8.00  HRS               AAA =.10891E 01SIGG =.24772E 01

     GEOMN =.12000E-01    ARIMN =.18108E-01
SEASON = 3
POLLUTANT = 1
STANDARD = 2

     JFLAG = 2
                                 AQ Standard for SOx, Annual
     ARIMN =.15000E-01
SEASON = 3
POLLUTANT = 3
STANDARD = 1


     AVTM = 8.00  HRS               AAA =.10891E 01SIGG =.19198E 01

     F =.10000E-01  Z =.23268E 01          GEOMN =.32887E-04        AQSTAN =.15000E-03
                                           AQ Standard for Particulates, Annual
     GEOMN =.32887E-04    ARIMN =.40681E-04
SEASON = 3
POLLUTANT = 3
STANDARD = 2

     JFLAG = 2

     ARIMN =.80000E-04
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CALIBRATION USING 12 MEASURING STATIONS

Station Number

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 1   74.55   68.50 0.61000E-01 0.70000E-04 0.21000E-01 0.66770E-04 0.36870E-01 0.79466E-04
 1   74.55   68.50 0.55806E-01 0.69744E-04 0.45421E-01 0.83068E-04 0.36873E-01 0.79517E-04
 2   79.55   69.90 0.10000E 00 0.10000E-03 0.21000E-01 0.79440E-04 0.57099E-01 0.12778E-03
 2   79.55   69.90 0.11233E 00 0.10377E-03 0.74886E-01 0.14268E-03 0.57158E-01 0.12799E-03
 3   82.05   53.40 0.30000E-01 0.60000E-04 0.36000E-01 0.68330E-04 0.36348E-01 0.76498E-04
 3   82.05   53.40 0.34[illegible]9E-01 0.57575E-04 0.47675E-01 0.98038E-04 0.36345E-01 0.76514E-04
 4   82.55   79.30 0.40000E-01 0.80000E-04 0.69000E-01 0.95080E-04 0.36567E-01 0.88525E-04
 4   82.55   79.30 0.35545E-01 0.81136E-04 0.46335E-01 0.93115E-04 0.36549E-01 0.88632E-04
 5   83.05   69.50 0.10000E 00 0.10000E-03 0.45000E-01 0.87260E-04 0.82760E-01 0.16689E-03
 5   83.05   69.50 0.10[illegible]0E 00 0.12277E-03 0.12061E 00 0.21370E-03 0.82642E-01 0.16662E-03
 6   83.55   58.00 0.60[illegible]0E-01 0.80000E-04 0.34000E-01 0.28430E-03 0.55131E-01 0.99746E-04
 6   93.55   58.00 0.62356E-01 0.81008E-04 0.65962E-01 0.11150E-03 0.55124E-01 0.99755E-04
 7   89.25   63.50 0.80000E-01 0.20000E-03 0.28000E-01 0.10200E-03 0.11461E 00 0.18575E-03
 7   89.25   63.50 0.85781E-01 0.15573E-03 0.16118E 00 0.23081E-03 0.11450E 00 0.18541E-03
 8   91.85   72.50 0.60000E-01 0.20000E-03 0.62000E-01 0.10110E-03 0.69443E-01 0.15836E-03
 8   91.85   72.50 0.67694E-01 0.16507E-03 0.83141E-01 0.16548E-03 0.69077E-01 0.15880E-03
 9   98.45   68.00 0.30000E-01 0.70000E-04 0.49000E-01 0.14070E-03 0.39506E-01 0.79184E-04
 9   98.45   68.00 0.34311E-01 0.65855E-04 0.52421E-01 0.94259E-04 0.39461E-01 0.79257E-04
10   94.55   68.00 0.40000E-01 0.10000E-03 0.86000E-01 0.19000E-03 0.48972E-01 0.11787E-03
10   94.55   68.00 0.42601E-01 0.10051E-03 0.64827E-01 0.13691E-03 0.48705E-01 0.11713E-03
11  101.25   94.00 0.10000E-01 0.30000E-04 0.33000E-01 0.15420E-03 0.10777E-01 0.31242E-04
11  101.25   94.00 0.91483E-02 0.32099E-04 0.13871E-01 0.31951E-04 0.10776E-01 0.31294E-04
12  105.05   64.60 0.10000E-01 0.40000E-04 0.20000E-01 0.11270E-03 0.17869E-01 0.47958E-04
12  105.05   64.60 0.12206E-01 0.36566E-04 0.27152E-01 0.59462E-04 0.17861E-01 0.48034E-04
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Measured Air Quality

Computed Air Quality

Regression Lines

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SOX Sum    Y-INTERCEPT=     0.00133SLOPE=     0.91944R=     0.99255CORRELATION COEFFICIENT=     0.57600DEG. OF FREEDOM=   10
Part Sum   Y-INTERCEPT=    -0.00002SLOPE=     1.23024R=     0.96172CORRELATION COEFFICIENT=     0.57600DEG. OF FREEDOM=   10
SOX Win              POOR CORRELATION         R=      0.01883
Part Win             POOR CORRELATION         R=     -0.15867
SOX Ann    Y-INTERCEPT=    -0.00002SLOPE=     1.00178R=     0.99999CORRELATION COEFFICIENT=     0.57600DEG. OF FREEDOM=   10
Part Ann.  Y-INTERCEPT=    -0.00000SLOPE=     1.00152R=     0.99998CORRELATION COEFFICIENT=     0.57600DEG. OF FREEDOM=   10
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RECEPTOR DATA

ST. LOUIS....TEST CASE-B

AVERAGE CONCENTRATIONS OF SOX (HALF LIFE=3 HRS) FOR THE ANNUAL SEASON
PAGE NO. 1 DISTANCES IN KILOMETERS, CONCENTRATIONS IN PARTS PER MILLION

ORDINATE	ABCISSA				
	0.0	15.000	30.000	45.000	60.000
0.0	0.18604E-03	0.33179E-03	0.64407E-03	0.11768E-02	0.19129E-02
15.00	0.26184E-03	0.49180E-03	0.96208E-03	0.20343E-02	0.55582E-02
30.00	0.31773E-03	0.61819E-03	0.13237E-02	0.32304E-02	0.12761E-01
45.00	0.39774E-03	0.75441E-03	0.15526E-02	0.35890E-02	0.88779E-02
60.00	0.40784E-03	0.79580E-03	0.15924E-02	0.33233E-02	0.80349E-02
75.00	0.42670E-03	0.77456E-03	0.15432E-02	0.31724E-02	0.77014E-02
90.00	0.40878E-03	0.73628E-03	0.14314E-02	0.27998E-02	0.56223E-02
105.00	0.36914E-03	0.66759E-03	0.12338E-02	0.22214E-02	0.37486E-02
120.00	0.32820E-03	0.56903E-03	0.96734E-03	0.17122E-02	0.29642E-02
135.00	0.26342E-03	0.45268E-03	0.75596E-03	0.12646E-02	0.20590E-02

ORDINATE	ABCISSA				
	75.000	90.000	105.000	120.000	135.000
0.0	0.30780E-02	0.33135E-02	0.25201E-02	0.17731E-02	0.12848E-02
15.00	0.13115E-01	0.81972E-02	0.40507E-02	0.25972E-02	0.17869E-02
30.00	0.42144E-01	0.91520E-02	0.52049E-02	0.36319E-02	0.23931E-02
45.00	0.15231E-01	0.13142E-01	0.92716E-02	0.54578E-02	0.30891E-02
60.00	0.26569E-01	0.53054E-01	0.17882E-01	0.67499E-02	0.33677E-02
75.00	0.25820E-01	0.70781E-01	0.15127E-01	0.62875E-02	0.32761E-02
90.00	0.11063E-01	0.18676E-01	0.10269E-01	0.50822E-02	0.27663E-02
105.00	0.58186E-02	0.88822E-02	0.52982E-02	0.31377E-02	0.18858E-02
120.00	0.48934E-02	0.51632E-02	0.32746E-02	0.21142E-02	0.13123E-02
135.00	0.30208E-02	0.29548E-02	0.21855E-02	0.13565E-02	0.91952E-03

ORDINATE		
	150.000	165.000
0.0	0.92569E-03	0.66299E-03
15.00	0.12167E-02	0.82080E-03
30.00	0.14968E-02	0.94135E-03
45.00	0.17604E-02	0.10356E-02
60.00	0.17941E-02	0.10025E-02
75.00	0.16965E-02	0.92211E-03
90.00	0.13696E-02	0.75920E-03
105.00	0.10612E-02	0.60983E-03
120.00	0.78569E-03	0.48735E-03
135.00	0.58058E-03	0.36710E-03

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                         R E C E P T O R   D A T A

 ST. LOUIS....TEST CASE-B

 AVERAGE CONCENTRATIONS OF         PARTICULATE        FOR THE ANNUAL SEASON
PAGE NO.  1  DISTANCES IN KILOMETERS, CONCENTRATIONS IN MICROGRAMS/CU. METER
ORDINATE |                              ABCISSA
         |        0.0  |     15.000|     30.000|     45.000|     60.000|
     0.0 | 0.37571E-05| 0.45061E-05| 0.54501E-05| 0.64954E-05| 0.74296E-05|
   15.00| 0.42077E-05| 0.51993E-05| 0.65086E-05| 0.88324E-05| 0.12507E-04|
   30.00| 0.44307E-05| 0.56189E-05| 0.76604E-05| 0.11232E-04| 0.22859E-04|
   45.00| 0.50198E-05| 0.65525E-05| 0.92987E-05| 0.14820E-04| 0.28279E-04|
   60.00| 0.52724E-05| 0.69273E-05| 0.10041E-04| 0.15515E-04| 0.35540E-04|
   75.00| 0.57793E-05| 0.75496E-05| 0.10612E-04| 0.16256E-04| 0.29320E-04|
   90.00| 0.62255E-05| 0.79492E-05| 0.10931E-04| 0.15680E-04| 0.24690E-04|
  105.00| 0.64481E-05| 0.80259E-05| 0.10386E-04| 0.13787E-04| 0.19305E-04|
  120.00| 0.63622E-05| 0.76193E-05| 0.92284E-05| 0.11491E-04| 0.14342E-04|
  135.00| 0.59346E-05| 0.69163E-05| 0.80147E-05| 0.94227E-05| 0.10944E-04|

ORDINATE |                              ABCISSA
         |     75.000|     90.000|    105.000|    120.000|    135.000|
     0.0 | 0.92281E-05| 0.98825E-05| 0.96424E-05| 0.89695E-05| 0.82014E-05|
   15.00| 0.17615E-04| 0.16231E-04| 0.13694E-04| 0.11737E-04| 0.10133E-04|
   30.00| 0.12640E-03| 0.24180E-04| 0.18399E-04| 0.15242E-04| 0.12268E-04|
   45.00| 0.43037E-04| 0.36955E-04| 0.29011E-04| 0.20775E-04| 0.14749E-04|
   60.00| 0.84820E-04| 0.10578E-03| 0.50126E-04| 0.23986E-04| 0.15380E-04|
   75.00| 0.67819E-04| 0.16762E-03| 0.43251E-04| 0.22465E-04| 0.15129E-04|
   90.00| 0.43941E-04| 0.63964E-04| 0.30268E-04| 0.19116E-04| 0.13402E-04|
  105.00| 0.27161E-04| 0.31543E-04| 0.19696E-04| 0.14105E-04| 0.10800E-04|
  120.00| 0.17826E-04| 0.19855E-04| 0.14527E-04| 0.11417E-04| 0.89114E-05|
  135.00| 0.13264E-04| 0.14174E-04| 0.11605E-04| 0.90536E-05| 0.76248E-05|

ORDINATE |
         |    150.000|    165.000|
     0.0 | 0.74658E-05| 0.66192E-05|
   15.00| 0.86981E-05| 0.75082E-05|
   30.00| 0.98858E-05| 0.81151E-05|
   45.00| 0.10937E-04| 0.85325E-05|
   60.00| 0.10902E-04| 0.82420E-05|
   75.00| 0.10492E-04| 0.77661E-05|
   90.00| 0.91827E-05| 0.70193E-05|
  105.00| 0.81316E-05| 0.63942E-05|
  120.00| 0.70445E-05| 0.58212E-05|
  135.00| 0.62362E-05| 0.52219E-05|
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POLLUTANT CONCENTRATIONS ABOVE STANDARD

POLLUTANT : SOx

SEASON 3 ANNUAL

AIR QUALITY STANDARD = 0.15000E-01 ARITHMETIC MEAN, PPM

RECEPTOR NUMBER	ARITHMETIC MEAN CONCENTRATION	EXCESS ABOVE AIR QUALITY STANDARD	CONTRIBUTION FROM POINT SOURCES	CONTRIBUTION FROM AREA SOURCES	NECESSARY REDUCTION FOR POINT SOURCES	NECESSARY REDUCTION FOR ALL SOURCES
127	0.11370E 00	0.98705E-01	0.97843E-01	0.15862E-01	100.88130	86.80789
125	0.82329E-01	0.67329E-01	0.49080E-01	0.33249E-01	137.18147	81.78035
66	0.70781E-01	0.55781E-01	0.57326E-01	0.13455E-01	97.30455	78.80792
128	0.69114E-01	0.54114E-01	0.53219E-01	0.15895E-01	101.68161	78.29671
126	0.54916E-01	0.39916E-01	0.45303E-01	0.96132E-02	88.10944	72.68578
122	0.54809E-01	0.39809E-01	0.33652E-01	0.21157E-01	118.29442	72.63225
65	0.53054E-01	0.38054E-01	0.41881E-01	0.11173E-01	90.86179	71.72682
130	0.48762E-01	0.33762E-01	0.35723E-01	0.13039E-01	94.51062	69.23824
53	0.42144E-01	0.27144E-01	0.41468E-01	0.67642E-03	65.45854	64.40793
129	0.39485E-01	0.24485E-01	0.31288E-01	0.81970E-02	78.25684	62.01094
124	0.36118E-01	0.21118E-01	0.23816E-01	0.12302E-01	88.67146	58.46909
123	0.35501E-01	0.20501E-01	0.30323E-01	0.51781E-02	67.60899	57.74767
121	0.29812E-01	0.14812E-01	0.17651E-01	0.12161E-01	83.91463	49.68498
55	0.26569E-01	0.11569E-01	0.20682E-01	0.58868E-02	55.93753	43.54381
56	0.25820E-01	0.10820E-01	0.15203E-01	0.10617E-01	71.16982	41.90547
67	0.18676E-01	0.36762E-02	0.14081E-01	0.45956E-02	26.10806	19.68369
75	0.17882E-01	0.28819E-02	0.13334E-01	0.45477E-02	21.61311	16.11649
132	0.17873E-01	0.28733E-02	0.13065E-01	0.48082E-02	21.99232	16.07608
54	0.15231E-01	0.23067E-03	0.13431E-01	0.18002E-02	1.71748	1.51449
76	0.15127E-01	0.12664E-03	0.11107E-01	0.40192E-02	1.14018	0.83723

POLLUTANT CONCENTRATIONS ABOVE STANDARD

POLLUTANT 3 PARTICULATES

SEASON 3 ANNUAL

AIR QUALITY STANDARD = 0.40681E-04 ARITHMETIC MEAN, g/m³

RECEPTOR NUMBER	ARITHMETIC MEAN CONCENTRATION	EXCESS ABOVE AIR QUALITY STANDARD	CONTRIBUTION FROM POINT SOURCES	CONTRIBUTION FROM AREA SOURCES	NECESSARY REDUCTION FOR POINT SOURCES	NECESSARY REDUCTION FOR ALL SOURCES
127	0.18467E-03	0.14398E-03	0.15280E-03	0.31862E-04	94.22821	77.97031
66	0.16762E-03	0.12694E-03	0.13670E-03	0.30920E-04	92.85939	75.72980
125	0.16572E-03	0.12504E-03	0.11236E-03	0.53365E-04	111.28873	75.45201
128	0.15874E-03	0.11806E-03	0.12121E-03	0.37537E-04	97.40590	74.37289
53	0.12640E-03	0.85716E-04	0.12306E-03	0.33364E-05	69.65340	67.81482
122	0.12377E-03	0.83087E-04	0.87168E-04	0.36601E-04	95.31879	67.13109
130	0.11714E-03	0.76463E-04	0.88652E-04	0.28492E-04	86.25026	65.27232
65	0.10578E-03	0.65095E-04	0.81320E-04	0.24456E-04	80.04767	61.54018
126	0.99491E-04	0.58810E-04	0.74035E-04	0.25457E-04	79.43587	59.11072
124	0.88034E-04	0.47353E-04	0.61598E-04	0.26437E-04	76.87457	53.78922
55	0.84820E-04	0.44139E-04	0.70346E-04	0.14475E-04	62.74596	52.03827
129	0.79204E-04	0.38523E-04	0.59420E-04	0.19784E-04	64.83104	48.63725
123	0.75557E-04	0.34876E-04	0.60837E-04	0.14721E-04	57.32718	46.15831
121	0.73893E-04	0.33212E-04	0.50262E-04	0.23632E-04	66.07803	44.94585
56	0.67819E-04	0.27138E-04	0.45440E-04	0.22379E-04	59.72240	40.01483
67	0.63964E-04	0.23282E-04	0.51188E-04	0.12776E-04	45.48395	36.39926
75	0.50126E-04	0.94447E-05	0.38133E-04	0.11993E-04	24.76799	18.84187
132	0.47970E-04	0.72885E-05	0.35153E-04	0.12817E-04	20.73338	15.19387
57	0.43941E-04	0.32594E-05	0.33111E-04	0.10829E-04	9.84362	7.41761
76	0.43251E-04	0.25699E-05	0.31696E-04	0.11555E-04	8.10783	5.94176
54	0.43037E-04	0.23555E-05	0.36769E-04	0.62674E-05	6.40604	5.47313

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT 1 SOx
SEASON 3 ANNUAL

AVERAGING TIME 1. HRS. STANDARD DEVIATION = 2.81
ALL VALUES PPM

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	7.701375E-03	4.516263E-03	2.322426E-01	1.100238E-01	4.998048E-02	1.697799E-02
56	2.581999E-02	1.514143E-02	7.786275E-01	3.688710E-01	1.675669E-01	5.692121E-02
66	7.078117E-02	4.150771E-02	2.134477E 00	1.011198E 00	4.593567E-01	1.560400E-01
76	1.512664E-02	8.870609E-03	4.561589E-01	2.161030E-01	9.816903E-02	3.334729E-02
86	6.287541E-03	3.637160E-03	1.896071E-01	8.982545E-02	4.080498E-02	1.386114E-02
121	2.981217E-02	1.748254E-02	8.990157E-01	4.259043E-01	1.934754E-01	6.572211E-02
122	5.480903E-02	3.214128E-02	1.652821E 00	7.830161E-01	3.557005E-01	1.208287E-01
123	3.550099E-02	2.081860E-02	1.070568E 00	5.071764E-01	2.303948E-01	7.826334E-02
124	3.611768E-02	2.118024E-02	1.089165E 00	5.159864E-01	2.343970E-01	7.962286E-02
125	8.232898E-02	4.827962E-02	2.482713E 00	1.176173E 00	5.342999E-01	1.814976E-01
126	5.491647E-02	3.220429E-02	1.656061E 00	7.845509E-01	3.563977E-01	1.210656E-01
127	1.137047E-01	6.667906E-02	3.428879E 00	1.624414E 00	7.379225E-01	2.506665E-01

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                              STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT   :  SOx
SEASON   3     ANNUAL

AVERAGING TIME   8. HRS.     STANDARD DEVIATION =  2.48
ALL VALUES PPM
RECEPTOR | ARITHMETIC  | GEOMETRIC  |    MAXIMUM     |      0.1%      |      1.0%      |      10.0%     |
         |    MEAN     |    MEAN    | CONCENTRATION  | CONCENTRATION  | CONCENTRATION  | CONCENTRATION  |
----------------------------------------------------------------------------------------------------------

   46     7.701375E-03  5.103563E-03  9.866202E-02     8.422554E-02     4.212646E-02     1.632430E-02

   56     2.581999E-02  1.711046E-02  3.307790E-01     2.823785E-01     1.412351E-01     5.472962E-02

   66     7.078117E-02  4.690548E-02  9.067752E-01     7.740935E-01     3.871725E-01     1.500321E-01

   76     1.512664E-02  1.002417E-02  1.937869E-01     1.654314E-01     8.274257E-02     3.206336E-02

   86     6.287541E-03  4.166644E-03  8.054942E-02     6.876320E-02     3.439279E-02     1.332745E-02

  121     2.981217E-02  1.975602E-02  3.819227E-01     3.260387E-01     1.630723E-01     6.319165E-02

  122     5.480903E-02  3.632101E-02  7.021567E-01     5.994153E-01     2.998050E-01     1.161765E-01

  123     3.550099E-02  2.352590E-02  4.548020E-01     3.882542E-01     1.941901E-01     7.525003E-02

  124     3.611768E-02  2.393457E-02  4.627023E-01     3.949985E-01     1.975634E-01     7.655722E-02

  125     8.232898E-02  5.455801E-02  1.054713E 00     9.003853E-01     4.503389E-01     1.745095E-01

  126     5.491647E-02  3.639221E-02  7.035331E-01     6.005902E-01     3.003927E-01     1.164043E-01

  127     1.137047E-01  7.535017E-02  1.456667E 00     1.243524E 00     6.219639E-01     2.410154E-01
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STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT 1 SOx
SEASON 3 ANNUAL

AVERAGING TIME 24. HRS. STANDARD DEVIATION = 2.3
ALL VALUES PPM

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	7.701375E-03	5.444087E-03	6.299907E-02	7.142538E-02	3.790834E-02	1.583293E-02
56	2.581099E-02	1.825210E-02	2.112137E-01	2.394641E-01	1.267580E-01	5.308222E-02
66	7.078117E-02	5.003508E-02	5.790070E-01	6.564507E-01	3.474858E-01	1.455160E-01
76	1.512664E-02	1.069300E-02	1.237395E-01	1.402900E-01	7.426119E-02	3.109822E-02
86	6.287541E-03	4.444651E-03	5.143360E-02	5.831298E-02	3.086741E-02	1.292629E-02
121	2.981217E-02	2.107416E-02	2.438707E-01	2.764890E-01	1.463568E-01	6.128958E-02
122	5.480903E-02	3.874440E-02	4.483511E-01	5.083193E-01	2.690738E-01	1.126795E-01
123	3.550099E-02	2.509559E-02	2.904066E-01	3.292493E-01	1.742849E-01	7.298499E-02
124	3.611768E-02	2.553152E-02	2.954513E-01	3.349687E-01	1.773124E-01	7.425279E-02
125	8.232898E-02	5.819820E-02	6.734709E-01	7.635494E-01	4.041775E-01	1.692567E-01
126	5.491647E-02	3.882035E-02	4.492299E-01	5.093156E-01	2.696013E-01	1.129004E-01
127	1.137047E-01	8.037764E-02	9.301318E-01	1.054539E 00	5.582103E-01	2.337637E-01

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT 3 PARTICULATES
SEASON 3 ANNUAL

AVERAGING TIME 1. HRS. STANDARD DEVIATION = 2.10
ALL VALUES g/m³

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	2.931994E-05	2.225088E-05	3.781128E-04	2.209777E-04	1.253047E-04	5.765438E-05
56	6.781900E-05	5.146780E-05	8.746006E-04	5.111361E-04	2.898383E-04	1.333585E-04
66	1.676185E-04	1.272056E-04	2.161625E-03	1.263302E-03	7.163517E-04	3.296030E-04
76	4.325122E-05	3.282331E-05	5.577719E-04	3.259743E-04	1.848428E-04	8.504867E-05
86	2.246458E-05	1.704834E-05	2.897051E-04	1.693103E-04	9.600686E-05	4.417404E-05
121	7.389332E-05	5.607758E-05	9.529353E-04	5.569169E-04	3.157980E-04	1.453029E-04
122	1.237685E-04	9.392781E-05	1.596131E-03	9.328146E-04	5.289495E-04	2.433769E-04
123	7.555733E-05	5.734041E-05	9.743948E-04	5.694584E-04	3.229096E-04	1.485750E-04
124	8.803431E-05	6.680918E-05	1.135299E-03	6.634945E-04	3.762324E-04	1.731096E-04
125	1.657217E-04	1.257661E-04	2.137163E-03	1.249006E-03	7.082452E-04	3.258730E-04
126	9.949147E-05	7.550402E-05	1.283052E-03	7.498446E-04	4.251970E-04	1.956389E-04
127	1.846660E-04	1.401429E-04	2.381472E-03	1.391786E-03	7.892079E-04	3.631250E-04

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT 3 PARTICULATES
SEASON 2 ANNUAL

AVERAGING TIME 8. HRS. STANDARD DEVIATION = 1.92
All values g/m³

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	2.931994E-05	2.370242E-05	1.993362E-04	1.779050E-04	1.081082E-04	5.468201E-05
56	6.781900E-05	5.482532E-05	4.610780E-04	4.115063E-04	2.500615E-04	1.264832E-04
66	1.676185E-04	1.355039E-04	1.139581E-03	1.017062E-03	6.180413E-04	3.126103E-04
76	4.325122E-05	3.496456E-05	2.940500E-04	2.624360E-04	1.594755E-04	8.066400E-05
86	2.246458E-05	1.816050E-05	1.527289E-04	1.363086E-04	8.283113E-05	4.189667E-05
121	7.389332E-05	5.973583E-05	5.023752E-04	4.483636E-04	2.724587E-04	1.378119E-04
122	1.237685E-04	1.000552E-04	8.414595E-04	7.509920E-04	4.563578E-04	2.308296E-04
123	7.555733E-05	6.108102E-05	5.136882E-04	4.584603E-04	2.785942E-04	1.409153E-04
124	8.803431E-05	7.116751E-05	5.985152E-04	5.341670E-04	3.245992E-04	1.641850E-04
125	1.657217E-04	1.339705E-04	1.126685E-03	1.005552E-03	6.110475E-04	3.090727E-04
126	9.949147E-05	8.042956E-05	6.764084E-04	6.036861E-04	3.668440E-04	1.855528E-04
127	1.846660E-04	1.492852E-04	1.255481E-03	1.120501E-03	6.808988E-04	3.444043E-04

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT 3 PARTICULATES
SEASON 3 ANNUAL

AVERAGING TIME 24. HRS. STANDARD DEVIATION = 1.82
ALL VALUES g/m³

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	2.931994E-05	2.450716E-05	1.425121E-04	1.559727E-04	9.872401E-05	5.279994E-05
56	6.781900E-05	5.668671E-05	3.296400E-04	3.607753E-04	2.283553E-04	1.221298E-04
66	1.676185E-04	1.401044E-04	8.147242E-04	8.916766E-04	5.643931E-04	3.018507E-04
76	4.325122E-05	3.615166E-05	2.102263E-04	2.300826E-04	1.456324E-04	7.788767E-05
86	2.246458E-05	1.877708E-05	1.091910E-04	1.195043E-04	7.564110E-05	4.045466E-05
121	7.389332E-05	6.176395E-05	3.591648E-04	3.930887E-04	2.488082E-04	1.330686E-04
122	1.237685E-04	1.034522E-04	6.015874E-04	6.584085E-04	4.167443E-04	2.228848E-04
123	7.555733E-05	6.315482E-05	3.672529E-04	4.019407E-04	2.544113E-04	1.360652E-04
124	8.803431E-05	7.358374E-05	4.278983E-04	4.683142E-04	2.964227E-04	1.585340E-04
125	1.657217E-04	1.385190E-04	8.055046E-04	9.815860E-04	5.580061E-04	2.984349E-04
126	9.949147E-05	8.316025E-05	4.835869E-04	5.292627E-04	3.350025E-04	1.791663E-04
127	1.846660E-04	1.543536E-04	8.975852E-04	9.823639E-04	6.217943E-04	3.325501E-04

SOURCE CONTRIBUTIONS TO 5 RECEPTORS

PCLLUTANT 1 SEASON 3

SOx ANNUAL

SOURCE	RECEPTOR 127	RECEPTOR 125	RECEPTOR 66	RECEPTOR 128	RECEPTOR 126
1	0.29 %	1.78 %	0.58 %	0.53 %	0.19 %
2	1.41 %	1.29 %	4.08 %	6.09 %	0.67 %
3	0.83 %	5.17 %	0.59 %	0.58 %	1.11 %
4	0.16 %	0.61 %	0.10 %	0.11 %	0.31 %
5	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
6	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
7	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
8	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
9	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
10	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
11	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
12	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
13	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
14	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
15	0.74 %	1.44 %	7.97 %	10.79 %	0.57 %
16	0.34 %	0.32 %	0.13 %	0.16 %	0.27 %
17	4.80 %	4.51 %	1.61 %	1.94 %	4.23 %
18	0.10 %	0.07 %	0.10 %	0.13 %	0.11 %
19	0.07 %	0.11 %	0.29 %	0.24 %	0.08 %
20	0.04 %	0.06 %	0.17 %	0.14 %	0.05 %
21	2.46 %	4.19 %	10.01 %	9.27 %	1.49 %
22	2.32 %	0.85 %	0.37 %	0.43 %	0.50 %
23	0.69 %	0.95 %	0.34 %	0.40 %	13.82 %
24	0.58 %	0.41 %	1.86 %	3.04 %	0.43 %
25	20.10 %	2.34 %	1.91 %	2.16 %	1.77 %
26	10.95 %	5.35 %	4.27 %	4.54 %	4.82 %
27	21.20 %	3.68 %	2.74 %	2.98 %	3.40 %
28	1.37 %	1.97 %	0.77 %	0.87 %	15.46 %
29	1.65 %	2.35 %	0.91 %	1.03 %	21.08 %
30	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
31	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
32	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
33	7.25 %	0.40 %	0.30 %	0.34 %	0.44 %
34	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
35	0.14 %	0.50 %	1.05 %	0.76 %	0.12 %
36	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
37	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
38	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
39	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
40	1.66 %	0.14 %	0.14 %	0.37 %	0.13 %
41	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %

SOURCE CONTRIBUTIONS TO 5 RECEPTORS

POLLUTANT 1 SEASON 3

SOx annual

SOURCE	RECEPTOR 127	RECEPTOR 125	RECEPTOR 66	RECEPTOR 128	RECEPTOR 126
42	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
43	0.05 %	0.39 %	0.83 %	1.09 %	0.32 %
44	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
45	0.01 %	0.02 %	0.01 %	0.01 %	0.04 %
46	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
47	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
48	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
49	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
50	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
51	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
52	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
53	0.01 %	0.02 %	0.04 %	0.03 %	0.01 %
54	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
55	0.30 %	0.46 %	9.62 %	10.24 %	0.22 %
56	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
57	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
58	0.01 %	0.01 %	0.01 %	0.00 %	0.01 %
59	0.01 %	0.01 %	0.02 %	0.01 %	0.01 %
60	0.22 %	0.45 %	12.09 %	3.80 %	0.17 %
61	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
62	0.32 %	0.65 %	5.90 %	6.56 %	0.24 %
63	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
64	0.05 %	0.10 %	4.58 %	1.18 %	0.04 %
65	0.97 %	1.39 %	0.89 %	0.95 %	3.26 %
66	0.01 %	0.01 %	0.01 %	0.01 %	0.02 %
67	0.15 %	0.21 %	0.13 %	0.14 %	0.50 %
68	0.40 %	2.65 %	1.03 %	0.82 %	0.36 %
69	0.06 %	0.11 %	0.06 %	0.07 %	0.25 %
70	0.08 %	0.29 %	0.64 %	0.41 %	0.07 %
71	0.25 %	0.30 %	0.37 %	0.45 %	0.40 %
72	0.00 %	0.00 %	0.00 %	0.00 %	0.01 %
73	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
74	2.39 %	3.63 %	1.96 %	2.15 %	2.33 %
75	0.36 %	0.60 %	1.19 %	1.12 %	0.57 %
76	0.01 %	0.01 %	0.02 %	0.02 %	0.01 %
77	0.04 %	0.16 %	0.13 %	0.13 %	0.02 %
78	0.02 %	0.04 %	0.07 %	0.07 %	0.02 %
79	0.04 %	0.05 %	0.02 %	0.02 %	0.06 %
80	0.11 %	0.63 %	0.30 %	0.25 %	0.10 %
81	0.38 %	7.77 %	0.45 %	0.40 %	0.36 %
82	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %

SOURCE CONTRIBUTIONS TO 5 RECEPTORS

POLLUTANT 1 SEASON 3
SOx ANNUAL

SOURCE	RECEPTOR 127	RECEPTOR 125	RECEPTOR 66	RECEPTOR 128	RECEPTOR 126
83	0.33 %	1.01 %	0.21 %	0.23 %	0.87 %
84	0.12 %	0.16 %	0.07 %	0.08 %	1.16 %
85	0.01 %	0.01 %	0.04 %	0.03 %	0.01 %
86	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
87	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
88	0.04 %	0.03 %	0.03 %	0.03 %	0.11 %
89	0.00 %	0.01 %	0.02 %	0.02 %	0.01 %
90	0.02 %	0.03 %	0.08 %	0.07 %	0.02 %
91	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
92	0.00 %	0.00 %	0.01 %	0.01 %	0.00 %
93	0.01 %	0.02 %	0.02 %	0.02 %	0.01 %
94	0.01 %	0.03 %	0.05 %	0.04 %	0.01 %
95	0.00 %	0.01 %	0.02 %	0.01 %	0.00 %
96	0.00 %	0.01 %	0.02 %	0.01 %	0.00 %
97	0.01 %	0.02 %	0.04 %	0.03 %	0.01 %
98	0.00 %	0.01 %	0.03 %	0.02 %	0.00 %
99	0.00 %	0.00 %	0.02 %	0.01 %	0.00 %
100	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
101	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
102	0.00 %	0.01 %	0.01 %	0.01 %	0.01 %
103	0.06 %	0.15 %	0.12 %	0.11 %	0.09 %
104	0.03 %	0.09 %	0.10 %	0.08 %	0.05 %
105	0.07 %	0.21 %	0.33 %	0.25 %	0.07 %
106	0.03 %	0.09 %	0.30 %	0.18 %	0.03 %
107	0.03 %	0.06 %	0.31 %	0.22 %	0.02 %
108	0.06 %	0.12 %	0.55 %	0.63 %	0.06 %
109	0.01 %	0.01 %	0.02 %	0.02 %	0.01 %
110	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
111	0.28 %	1.17 %	0.75 %	0.65 %	0.27 %
112	0.10 %	0.28 %	0.42 %	0.33 %	0.07 %
113	0.10 %	0.28 %	0.42 %	0.33 %	0.07 %
114	0.20 %	0.27 %	2.00 %	4.79 %	0.14 %
115	0.08 %	0.21 %	0.11 %	0.11 %	0.17 %
116	0.95 %	3.29 %	1.52 %	1.39 %	1.55 %
117	1.41 %	16.98 %	1.81 %	1.72 %	1.34 %
118	1.00 %	3.01 %	1.59 %	1.58 %	0.71 %
119	0.62 %	0.96 %	1.45 %	1.71 %	0.39 %
120	0.10 %	0.10 %	0.31 %	0.43 %	0.06 %
121	1.42 %	3.87 %	0.94 %	1.01 %	1.78 %
122	1.42 %	3.87 %	0.94 %	1.01 %	1.78 %
123	0.68 %	0.60 %	0.55 %	0.65 %	0.38 %

SOURCE CONTRIBUTIONS TO 5 RECEPTORS

POLLUTANT 1 SEASON 3

SOx ANNUAL

SOURCE	RECEPTOR 127	RECEPTOR 125	RECEPTOR 66	RECEPTOR 128	RECEPTOR 126
124	0.46 %	0.31 %	0.47 %	0.70 %	0.25 %
125	0.10 %	0.20 %	0.12 %	0.19 %	0.33 %
126	0.33 %	0.65 %	0.28 %	0.29 %	0.91 %
127	0.41 %	0.65 %	0.22 %	0.24 %	1.34 %
128	1.35 %	1.10 %	0.53 %	0.59 %	1.72 %
129	1.02 %	0.20 %	0.14 %	0.19 %	0.26 %
130	0.07 %	0.03 %	0.03 %	0.04 %	0.03 %
131	0.00 %	0.01 %	0.01 %	0.01 %	0.01 %
132	0.00 %	0.00 %	0.00 %	0.00 %	0.01 %
133	0.01 %	0.01 %	0.01 %	0.01 %	0.04 %
134	0.01 %	0.01 %	0.00 %	0.00 %	0.03 %
135	0.06 %	0.05 %	0.06 %	0.08 %	0.09 %
136	0.00 %	0.00 %	0.01 %	0.01 %	0.01 %
137	0.00 %	0.00 %	0.00 %	0.00 %	0.01 %
138	0.00 %	0.01 %	0.00 %	0.00 %	0.01 %
139	0.01 %	0.01 %	0.01 %	0.01 %	0.02 %
140	0.00 %	0.00 %	0.00 %	0.00 %	0.01 %
141	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
142	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
143	0.00 %	0.00 %	0.01 %	0.01 %	0.00 %
144	0.00 %	0.01 %	0.02 %	0.02 %	0.01 %
145	0.01 %	0.01 %	0.02 %	0.02 %	0.01 %
146	0.01 %	0.01 %	0.03 %	0.02 %	0.01 %
147	0.00 %	0.00 %	0.01 %	0.00 %	0.00 %
148	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
149	0.01 %	0.01 %	0.04 %	0.03 %	0.01 %
150	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
151	0.00 %	0.01 %	0.00 %	0.00 %	0.01 %
152	0.01 %	0.02 %	0.01 %	0.01 %	0.03 %
153	0.23 %	0.26 %	0.77 %	1.38 %	0.21 %
154	0.04 %	0.04 %	0.12 %	0.14 %	0.04 %
155	0.26 %	0.25 %	0.16 %	0.17 %	1.97 %
156	0.60 %	0.47 %	0.79 %	1.13 %	0.48 %
157	0.02 %	0.02 %	0.03 %	0.04 %	0.02 %
158	0.04 %	0.04 %	0.08 %	0.09 %	0.04 %
159	0.01 %	0.01 %	0.01 %	0.01 %	0.02 %
160	0.01 %	0.02 %	0.01 %	0.01 %	0.05 %
161	0.02 %	0.03 %	0.02 %	0.02 %	0.07 %
162	0.03 %	0.02 %	0.02 %	0.02 %	0.05 %
163	0.01 %	0.01 %	0.01 %	0.01 %	0.05 %
164	0.07 %	0.06 %	0.09 %	0.11 %	0.09 %

SOURCE CONTRIBUTIONS TO 5 RECEPTORS

POLLUTANT 3 SEASON 3
PARTICULATES ANNUAL

SOURCE	RECEPTOR 127	RECEPTOR 66	RECEPTOR 125	RECEPTOR 126	RECEPTOR 53
1	0.55 %	0.74 %	2.39 %	0.70 %	0.05 %
2	3.69 %	7.14 %	2.84 %	10.59 %	0.24 %
3	1.57 %	0.85 %	7.06 %	0.87 %	0.16 %
4	0.44 %	0.22 %	1.23 %	0.24 %	0.05 %
5	0.16 %	0.43 %	0.18 %	0.50 %	0.04 %
6	0.33 %	1.35 %	0.59 %	1.20 %	0.05 %
7	0.55 %	0.53 %	0.60 %	0.59 %	0.03 %
8	0.51 %	0.80 %	0.64 %	0.89 %	0.04 %
9	0.93 %	0.45 %	2.14 %	0.48 %	0.06 %
10	1.05 %	0.78 %	0.81 %	0.88 %	0.06 %
11	1.83 %	0.70 %	1.27 %	0.76 %	0.13 %
12	0.92 %	0.23 %	0.60 %	0.28 %	0.04 %
13	0.08 %	0.16 %	0.11 %	0.16 %	0.04 %
14	0.94 %	0.61 %	1.11 %	0.58 %	0.10 %
15	1.04 %	5.67 %	1.55 %	8.42 %	0.19 %
16	0.83 %	0.28 %	0.68 %	0.33 %	0.05 %
17	1.19 %	0.34 %	0.94 %	0.40 %	0.07 %
18	0.38 %	0.27 %	0.25 %	0.35 %	0.11 %
19	0.05 %	0.11 %	0.06 %	0.10 %	0.02 %
20	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
21	1.00 %	2.57 %	1.31 %	2.44 %	0.11 %
22	3.88 %	0.51 %	1.26 %	0.61 %	0.06 %
23	1.17 %	0.50 %	1.33 %	0.58 %	0.25 %
24	0.22 %	0.47 %	0.14 %	0.73 %	0.04 %
25	0.56 %	0.04 %	0.06 %	0.05 %	0.00 %
26	11.95 %	4.01 %	5.69 %	4.30 %	0.48 %
27	0.52 %	0.06 %	0.09 %	0.06 %	0.01 %
28	0.60 %	0.29 %	0.71 %	0.33 %	0.17 %
29	0.03 %	0.02 %	0.04 %	0.02 %	0.01 %
30	0.63 %	0.48 %	0.69 %	0.53 %	27.03 %
31	1.41 %	1.06 %	1.54 %	1.17 %	63.11 %
32	1.92 %	6.14 %	1.70 %	9.56 %	0.16 %
33	26.06 %	0.95 %	1.44 %	1.08 %	0.12 %
34	3.03 %	0.31 %	0.47 %	0.36 %	0.04 %
35	0.11 %	0.46 %	0.26 %	0.35 %	0.02 %
36	0.10 %	0.08 %	0.13 %	0.08 %	0.12 %
37	0.00 %	0.01 %	0.00 %	0.01 %	0.00 %
38	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
39	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
40	0.27 %	0.02 %	0.02 %	0.02 %	0.00 %
41	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %

SOURCE CONTRIBUTIONS TO 5 RECEPTORS

POLLUTANT 3 SEASON 3
PARTICULATES ANNUAL

SOURCE	RECEPTOR 127	RECEPTOR 66	RECEPTOR 125	RECEPTOR 122	RECEPTOR 53
42	0.05 %	0.04 %	0.06 %	0.04 %	0.06 %
43	0.13 %	1.54 %	0.90 %	1.97 %	0.17 %
44	2.47 %	0.96 %	0.85 %	1.58 %	0.08 %
45	0.01 %	0.01 %	0.01 %	0.01 %	0.12 %
46	0.17 %	0.72 %	0.24 %	0.51 %	0.05 %
47	0.29 %	0.23 %	0.37 %	0.24 %	0.18 %
48	0.17 %	0.17 %	0.32 %	0.18 %	0.07 %
49	0.30 %	0.17 %	1.01 %	0.17 %	0.04 %
50	0.70 %	1.66 %	1.00 %	1.41 %	0.27 %
51	0.30 %	0.71 %	0.43 %	0.62 %	0.11 %
52	1.26 %	0.81 %	1.63 %	0.84 %	0.69 %
53	0.05 %	0.11 %	0.07 %	0.10 %	0.02 %
54	0.01 %	0.02 %	0.01 %	0.02 %	0.01 %
55	0.13 %	2.26 %	0.16 %	2.43 %	0.02 %
56	0.04 %	0.00 %	0.04 %	0.00 %	0.01 %
57	0.02 %	0.00 %	0.01 %	0.00 %	0.01 %
58	0.02 %	0.02 %	0.02 %	0.01 %	0.00 %
59	0.20 %	0.24 %	0.23 %	0.09 %	0.05 %
60	0.72 %	19.98 %	1.12 %	6.90 %	0.13 %
61	0.10 %	0.11 %	0.16 %	0.79 %	0.02 %
62	0.07 %	0.70 %	0.11 %	0.82 %	0.01 %
63	0.07 %	0.84 %	0.11 %	0.87 %	0.01 %
64	0.12 %	6.14 %	0.20 %	1.71 %	0.02 %
65	0.01 %	0.01 %	0.01 %	0.01 %	0.12 %
66	0.01 %	0.00 %	0.01 %	0.01 %	0.15 %
67	0.00 %	0.00 %	0.00 %	0.00 %	0.02 %
68	0.17 %	0.29 %	0.79 %	0.24 %	0.02 %
69	0.25 %	0.21 %	0.34 %	0.23 %	0.37 %
70	0.14 %	0.67 %	0.37 %	0.46 %	0.03 %
71	0.47 %	0.35 %	0.42 %	0.46 %	0.53 %
72	0.00 %	0.00 %	0.00 %	0.00 %	0.04 %
73	0.00 %	0.00 %	0.00 %	0.00 %	0.01 %
74	0.58 %	0.39 %	0.73 %	0.43 %	0.10 %
75	0.02 %	0.03 %	0.02 %	0.03 %	0.01 %
76	0.06 %	0.07 %	0.06 %	0.08 %	0.04 %
77	0.00 %	0.01 %	0.01 %	0.01 %	0.00 %
78	0.38 %	0.85 %	0.53 %	0.80 %	0.05 %
79	0.66 %	0.27 %	0.74 %	0.32 %	0.07 %
80	0.03 %	0.06 %	0.13 %	0.05 %	0.00 %
81	0.73 %	0.62 %	10.08 %	0.58 %	0.08 %
82	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %

SOURCE CONTRIBUTIONS TO 5 RECEPTORS

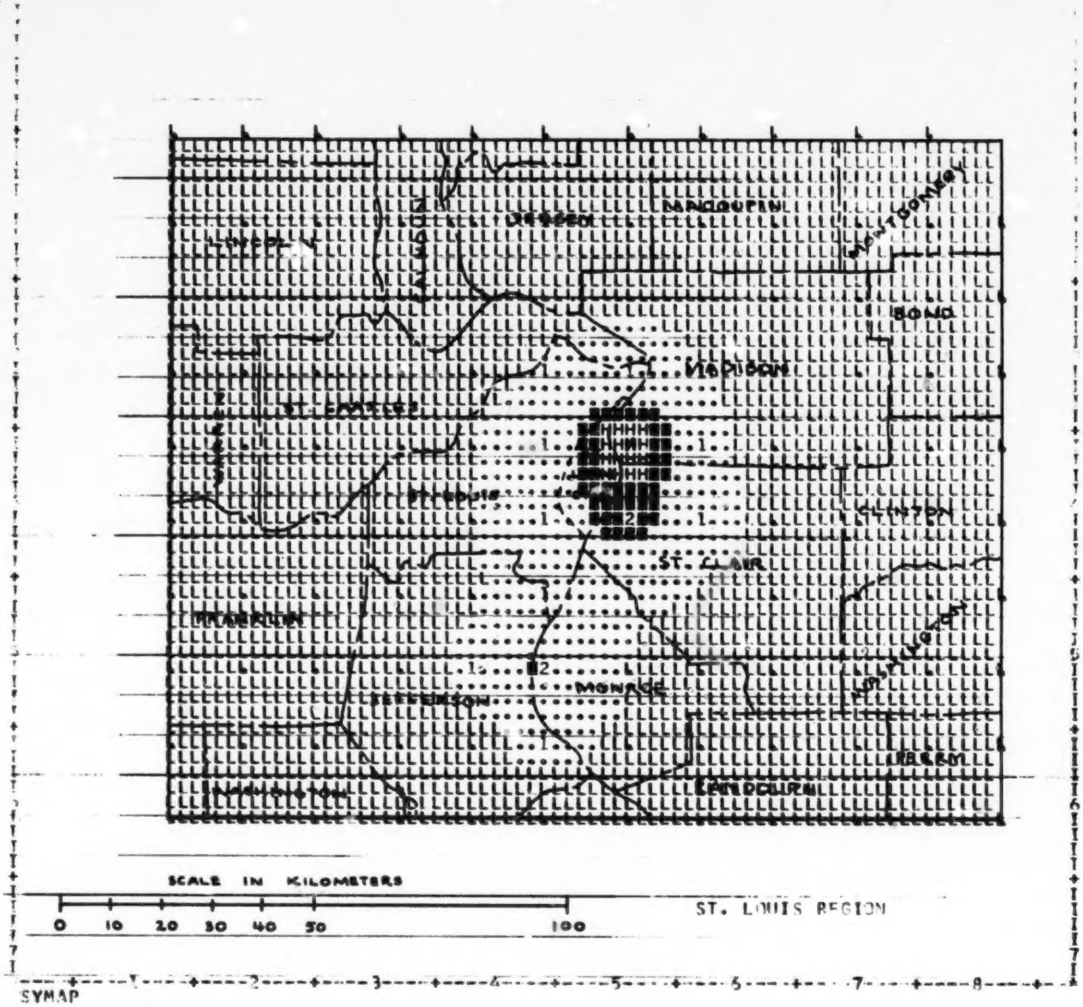
POLLUTANT 3 SEASON 3
PARTICULATES ANNUAL

SOURCE	RECEPTOR 127	RECEPTOR 66	RECEPTOR 125	RECEPTOR 128	RECEPTOR 53
83	0.92 %	0.47 %	2.09 %	0.51 %	0.13 %
84	0.37 %	0.19 %	0.43 %	0.22 %	0.17 %
85	0.01 %	0.01 %	0.01 %	0.01 %	0.00 %
86	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
87	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
88	0.02 %	0.01 %	0.01 %	0.01 %	0.01 %
89	0.01 %	0.02 %	0.01 %	0.02 %	0.01 %
90	0.03 %	0.08 %	0.05 %	0.08 %	0.02 %
91	0.01 %	0.01 %	0.01 %	0.01 %	0.00 %
92	0.01 %	0.02 %	0.01 %	0.02 %	0.00 %
93	0.01 %	0.02 %	0.02 %	0.02 %	0.00 %
94	0.01 %	0.03 %	0.02 %	0.02 %	0.00 %
95	0.01 %	0.02 %	0.01 %	0.01 %	0.00 %
96	0.00 %	0.01 %	0.01 %	0.01 %	0.00 %
97	0.01 %	0.04 %	0.02 %	0.03 %	0.00 %
98	0.01 %	0.03 %	0.01 %	0.02 %	0.00 %
99	0.01 %	0.04 %	0.01 %	0.03 %	0.00 %
100	0.00 %	0.02 %	0.01. %	0.02 %	0.00 %
101	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
102	0.03 %	0.04 %	0.04 %	0.04 %	0.02 %
103	0.10 %	0.13 %	0.17 %	0.13 %	0.03 %
104	0.04 %	0.07 %	0.08 %	0.07 %	0.01 %
105	0.08 %	0.24 %	0.18 %	0.20 %	0.01 %
106	0.05 %	0.24 %	0.09 %	0.16 %	0.01 %
107	0.04 %	0.20 %	0.06 %	0.15 %	0.01 %
108	0.09 %	0.41 %	0.14 %	0.50 %	0.02 %
109	0.02 %	0.02 %	0.02 %	0.02 %	0.01 %
110	0.00 %	0.01 %	0.00 %	0.01 %	0.00 %
111	0.57 %	0.98 %	1.64 %	0.90 %	0.08 %
112	0.16 %	0.41 %	0.32 %	0.34 %	0.02 %
113	0.16 %	0.41 %	0.32 %	0.34 %	0.02 %
114	0.45 %	2.58 %	0.51 %	6.19 %	0.06 %
115	0.16 %	0.15 %	0.28 %	0.16 %	0.06 %
116	0.89 %	0.97 %	2.09 %	0.94 %	0.20 %
117	1.25 %	1.13 %	10.35 %	1.11 %	0.12 %
118	0.93 %	1.02 %	2.08 %	1.05 %	0.08 %
119	1.08 %	1.71 %	1.36 %	2.03 %	0.09 %
120	0.56 %	1.14 %	0.50 %	1.58 %	0.06 %
121	1.28 %	0.66 %	2.65 %	0.72 %	0.11 %
122	1.28 %	0.66 %	2.65 %	0.72 %	0.11 %
123	0.56 %	0.35 %	0.44 %	0.42 %	0.03 %

SOURCE CONTRIBUTIONS TO 5 RECEPTORS

POLLUTANT 3 SEASON 3
PARTICULATES ANNUAL

SOURCE	RECEPTOR 127	RECEPTOR 66	RECEPTOR 125	RECEPTOR 128	RECEPTOR 53
124	0.37 %	0.29 %	0.24 %	0.43 %	0.03 %
125	0.17 %	0.14 %	0.26 %	0.15 %	0.08 %
126	0.67 %	0.46 %	1.32 %	0.68 %	0.17 %
127	0.34 %	0.15 %	0.45 %	0.17 %	0.04 %
128	1.55 %	0.51 %	1.10 %	0.57 %	0.10 %
129	1.03 %	0.13 %	0.20 %	0.16 %	0.02 %
130	0.08 %	0.03 %	0.03 %	0.04 %	0.00 %
131	0.02 %	0.02 %	0.03 %	0.03 %	0.04 %
132	0.01 %	0.01 %	0.01 %	0.01 %	0.02 %
133	0.01 %	0.01 %	0.01 %	0.01 %	0.02 %
134	0.01 %	0.01 %	0.01 %	0.01 %	0.01 %
135	0.21 %	0.17 %	0.17 %	0.20 %	0.09 %
136	0.01 %	0.01 %	0.01 %	0.01 %	0.01 %
137	0.01 %	0.01 %	0.01 %	0.01 %	0.02 %
138	0.01 %	0.01 %	0.01 %	0.01 %	0.02 %
139	0.01 %	0.01 %	0.01 %	0.01 %	0.03 %
140	0.01 %	0.00 %	0.01 %	0.01 %	0.01 %
141	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
142	0.00 %	0.01 %	0.01 %	0.01 %	0.00 %
143	0.01 %	0.01 %	0.01 %	0.01 %	0.00 %
144	0.01 %	0.02 %	0.02 %	0.02 %	0.01 %
145	0.02 %	0.05 %	0.03 %	0.04 %	0.01 %
146	0.01 %	0.02 %	0.01 %	0.02 %	0.00 %
147	0.00 %	0.01 %	0.00 %	0.00 %	0.00 %
148	0.01 %	0.02 %	0.01 %	0.02 %	0.00 %
149	0.02 %	0.04 %	0.02 %	0.04 %	0.01 %
150	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
151	0.01 %	0.01 %	0.01 %	0.01 %	0.01 %
152	0.02 %	0.02 %	0.03 %	0.02 %	0.02 %
153	0.24 %	0.50 %	0.23 %	0.84 %	0.05 %
154	0.19 %	0.36 %	0.18 %	0.42 %	0.05 %
155	1.36 %	0.71 %	1.16 %	0.77 %	0.34 %
156	0.54 %	0.53 %	0.41 %	0.74 %	0.08 %
157	0.02 %	0.03 %	0.02 %	0.04 %	0.01 %
158	0.05 %	0.06 %	0.04 %	0.07 %	0.02 %
159	0.01 %	0.01 %	0.01 %	0.01 %	0.01 %
160	0.01 %	0.01 %	0.01 %	0.01 %	0.01 %
161	0.04 %	0.03 %	0.05 %	0.03 %	0.02 %
162	0.15 %	0.07 %	0.09 %	0.08 %	0.03 %
163	0.01 %	0.01 %	0.01 %	0.01 %	0.01 %
164	0.09 %	0.09 %	0.08 %	0.11 %	0.05 %


LINCOLN
JERSEY
MACOUPIN
MONTGOMERY
BOND
MADISON
ST. CHARLES
ST. LOUIS
CLINTON
ST. CLAIR
FRANKLIN
WASHINGTON
JEFFERSON
MONROE
PERRY
WASHINGTON
RANDOLPH
SCALE IN KILOMETERS
0 10 20 30 40 50 100
ST. LOUIS REGION

```
 SYMAP

TIME =     0.0

2  SO2 CONCENTRATION IN PARTS PER MILLION FOR THE ANNUAL SEASON



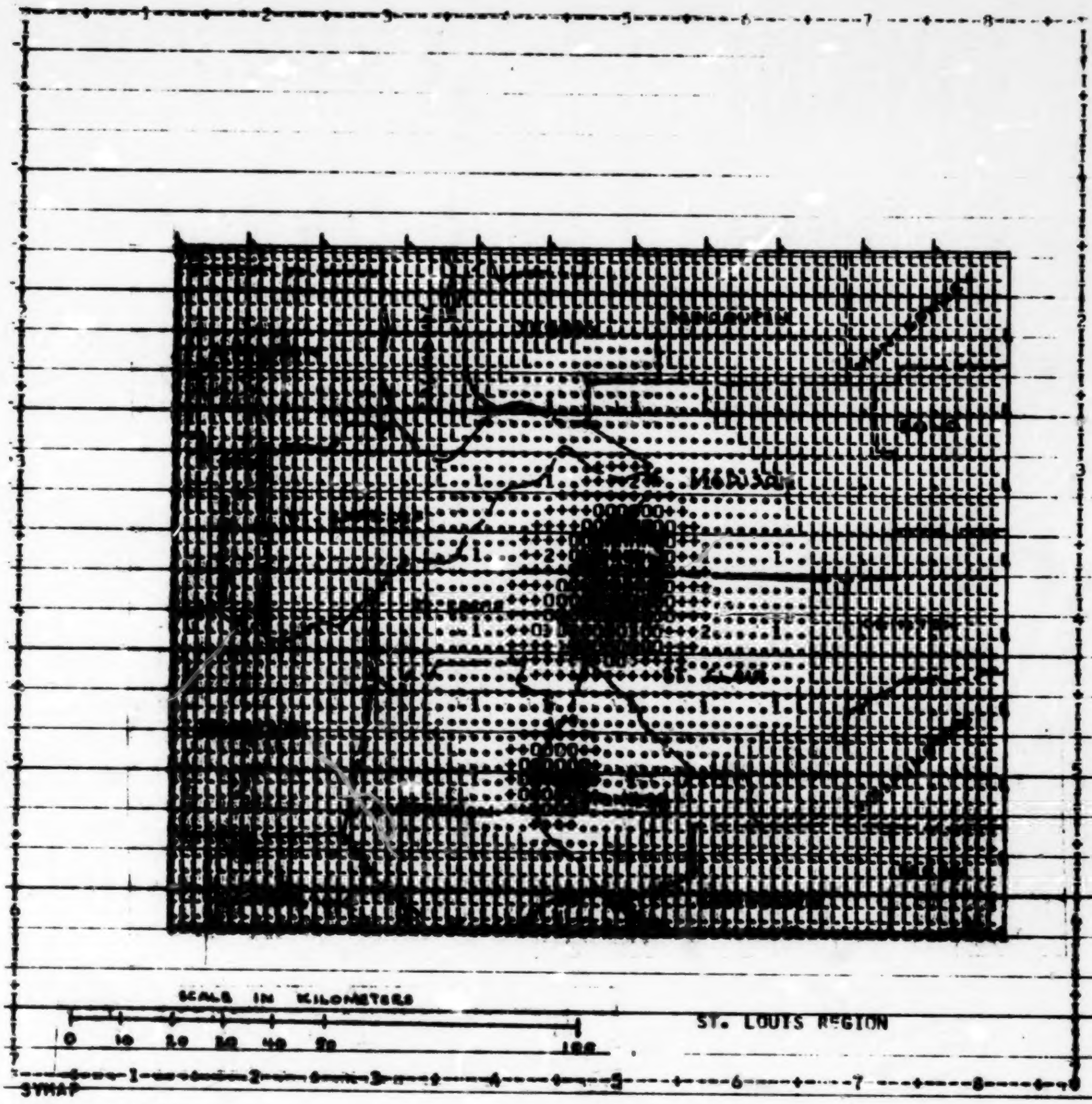
DATA VALUE EXTREMES ARE            0.00          0.07

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
                                                   ABOVE
  MINIMUM      BELOW        0.01        0.04        0.06
  MAXIMUM       0.01        0.04        0.06

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                         60.00      40.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          L          1          2          H
           ==========================================
            LLLLLLLLL  .........  █████████  HHHHHHHHH
            LLLLLLLLL  .........  █████████  HHHHHHHHH
  SYMBOLS   LLLLLLLLL  ....1....  ████2████  HHHHHHHHH
            LLLLLLLLL  .........  █████████  HHHHHHHHH
            LLLLLLLLL  .........  █████████  HHHHHHHHH
           ==========================================
```



```
SYMAP
TIME =    0.0

C   PARTICULATE CONCENTRATION IN MICROGRAMS PER CUBIC METER
C   FOR THE ANNUAL SEASON



DATA VALUE EXTREMES ARE           3.63      166.28


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
  MINIMUM       BELOW      20.00      50.00      80.00      110.00     ABOVE
  MAXIMUM       20.00      50.00      80.00     110.00      140.00     140.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                           25.00      25.00      25.00      25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL              L          1          2          3          4          H
                ==============================================================
                LLLLLLLLL  .........  +++++++++  000000000  █████████  HHHHHHHHH
                LLLLLLLLL  .........  +++++++++  000000000  █████████  HHHHHHHHH
  SYMBOLS       LLLLLLLLL  ....1....  ++++2++++  000030000  █████████  HHHHHHHHH
                LLLLLLLLL  .........  +++++++++  000000000  █████████  HHHHHHHHH
                LLLLLLLLL  .........  +++++++++  000000000  █████████  HHHHHHHHH
                ==============================================================
                ==========================================
```

CONTROL COST-EFFECTIVENESS REPORT

SIC= 2010 SITE= 900

	ORIGINAL EMISSIONS	
SOX	CO	PART
2.300	0.0	2.050

DEVICE	EFFICIENCIES			COST	CONTROLLED EMISSIONS			EFFECTIVENESS ($/TON)		
	SOX	CO	PART	DOLLARS	SOX	CO	PART	SOX	CO	PART
7	0.0	0.0	0.800	15529.49	2.300	0.0	0.410	0.0	0.0	25.94
10	0.0	0.0	0.980	46074.87	2.300	0.0	0.041	0.0	0.0	62.33
11	0.0	0.0	0.940	40087.14	2.300	0.0	0.123	0.0	0.0	56.99
12	0.0	0.0	0.880	34884.82	2.300	0.0	0.246	0.0	0.0	52.98
27	0.149	0.0	0.240	41615.44	1.957	0.0	1.558	331.95	0.0	231.69
28	0.575	0.0	0.240	59468.81	0.978	0.0	1.558	123.27	0.0	331.08
29	0.802	0.0	0.292	79569.25	0.455	0.0	1.450	118.18	0.0	363.60
30	0.522	0.0	0.974	92968.13	1.100	0.0	0.053	212.29	0.0	127.57
31	0.761	0.0	0.974	100072.69	0.550	0.0	0.053	156.68	0.0	137.31
32	0.880	0.0	0.974	114281.88	0.275	0.0	0.053	154.62	0.0	156.81
33	1.000	0.0	0.996	135487.56	0.0	0.0	0.008	161.39	0.0	181.76

CONTROL COST-EFFECTIVENESS REPORT

SIC= 2010 SITE= 910

	ORIGINAL EMISSIONS	
SOX	CO	PART
9.050	0.0	11.560

DEVICE	EFFICIENCIES			COST	CONTROLLED EMISSIONS			EFFECTIVENESS ($/TON)		
	SOX	CO	PART	DOLLARS	SOX	CO	PART	SOX	CO	PART
7	0.0	0.0	0.850	16955.89	9.050	0.0	1.734	0.0	0.0	4.73
8	0.0	0.0	0.700	14823.33	9.050	0.0	3.468	0.0	0.0	5.02
10	0.0	0.0	0.980	47389.57	9.050	0.0	0.231	0.0	0.0	11.46
11	0.0	0.0	0.950	41577.19	9.050	0.0	0.578	0.0	0.0	10.37
12	0.0	0.0	0.900	36668.68	9.050	0.0	1.156	0.0	0.0	9.56
27	0.521	0.0	0.574	92142.50	4.332	0.0	4.928	53.51	0.0	38.06
28	0.761	0.0	0.574	131672.38	2.166	0.0	4.928	52.40	0.0	54.39
29	0.889	0.0	0.603	176177.56	1.008	0.0	4.588	60.02	0.0	69.23
30	0.731	0.0	0.985	197559.50	2.436	0.0	0.169	81.83	0.0	47.51
31	0.865	0.0	0.985	213290.06	1.218	0.0	0.169	74.61	0.0	51.30
32	0.933	0.0	0.985	244751.06	0.609	0.0	0.169	79.44	0.0	58.86
33	1.000	0.0	0.998	291703.75	0.0	0.0	0.025	88.31	0.0	69.28

CONTROL COST-EFFECTIVENESS REPORT

SIC= 2010 SITE= 920

ORIGINAL EMISSIONS		
SOX	CO	PART
6.080	0.0	5.440

DEVICE	EFFICIENCIES SOX	CO	PART	COST DOLLARS	CONTROLLED EMISSIONS SOX	CO	PART	EFFECTIVENESS ($/TON) SOX	CO	PART
7	0.0	0.0	0.800	10470.87	6.080	0.0	1.088	0.0	0.0	6.59
10	0.0	0.0	0.980	37394.28	6.080	0.0	0.109	0.0	0.0	19.22
11	0.0	0.0	0.940	33870.89	6.080	0.0	0.326	0.0	0.0	18.15
12	0.0	0.0	0.880	30387.16	6.080	0.0	0.653	0.0	0.0	17.39
27	0.306	0.0	0.383	89704.44	4.217	0.0	3.358	131.95	0.0	118.05
28	0.653	0.0	0.383	128188.31	2.109	0.0	3.358	88.43	0.0	168.69
29	0.839	0.0	0.425	171515.88	0.982	0.0	3.127	92.17	0.0	203.12
30	0.610	0.0	0.979	193464.38	2.371	0.0	0.115	142.92	0.0	99.54
31	0.805	0.0	0.979	208778.69	1.186	0.0	0.115	116.87	0.0	107.42
32	0.902	0.0	0.979	239407.31	0.593	0.0	0.115	119.54	0.0	123.17
33	1.000	0.0	0.997	285117.56	0.0	0.0	0.017	128.48	0.0	144.04

CONTROL COST-EFFECTIVENESS REPORT

SIC= 2020 SITE= 2000

ORIGINAL EMISSIONS		
SOX	CO	PART
1.350	0.0	1.730

DEVICE	EFFICIENCIES SOX	CO	PART	COST DOLLARS	CONTROLLED EMISSIONS SOX	CO	PART	EFFECTIVENESS ($/TON) SOX	CO	PART
7	0.0	0.0	0.850	6861.56	1.350	0.0	0.259	0.0	0.0	12.78
8	0.0	0.0	0.700	6078.61	1.350	0.0	0.519	0.0	0.0	13.75
9	0.0	0.0	0.600	5143.55	1.350	0.0	0.692	0.0	0.0	13.58
10	0.0	0.0	0.980	22381.45	1.350	0.0	0.035	0.0	0.0	36.17
11	0.0	0.0	0.950	18616.09	1.350	0.0	0.086	0.0	0.0	31.03
12	0.0	0.0	0.900	14974.14	1.350	0.0	0.173	0.0	0.0	26.35
27	0.303	0.0	0.381	20008.98	0.941	0.0	1.070	133.94	0.0	83.07
28	0.652	0.0	0.381	28593.04	0.470	0.0	1.070	89.06	0.0	118.70
29	0.838	0.0	0.424	38257.48	0.219	0.0	0.996	92.67	0.0	142.85
30	0.608	0.0	0.979	43814.92	0.529	0.0	0.037	146.21	0.0	70.89
31	0.804	0.0	0.979	47230.86	0.264	0.0	0.037	119.21	0.0	76.42
32	0.902	0.0	0.979	54062.73	0.132	0.0	0.037	121.63	0.0	87.47
33	1.000	0.0	0.997	64258.61	0.0	0.0	0.005	130.41	0.0	102.08

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC= 2040      SITE= [illegible]          ORIGINAL EMISSIONS
                                                  SOX        CO          PART
                                                  [illegible]            1.98
                                               ------------------------------
DEVICE      EFFICIENCIES              COST        CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
         SOX        CO     PART      DOLLARS     SOX        CO           PART     SOX       CO         PART

  17     0.0       0.0     0.99     36485.47     0.[illegible]                      [illegible]         35.8[illegible]



                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2040      SITE=   111              ORIGINAL EMISSIONS
                                                  SOX        CO          PART
                                                  0.0        0.0         2.28[illegible]
                                               ------------------------------
DEVICE      EFFICIENCIES              COST        CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
         SOX        CO     PART      DOLLARS     SOX        CO           PART     SOX       CO         PART

  17     0.0       0.0     0.990    32580.98     0.0        0.0          0.023    0.0       0.0        39.55



                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2040      SITE=   121              ORIGINAL EMISSIONS
                                                  SOX        CO          PART
                                                  0.0        0.0         1.490
                                               ------------------------------
DEVICE      EFFICIENCIES              COST        CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
         SOX        CO     PART      DOLLARS     SOX        CO           PART     SOX       CO         PART

  17     0.0       0.0     0.99[illegible]    16815.24     0.[illegible]       [illegible]           [illegible]    [illegible]       [illegible]        3[illegible].[illegible]
```

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                                      CONTROL COST-EFFECTIVENESS REPORT

            SIC=  2040     SITE=   131                ORIGINAL EMISSIONS
                                                  SOX        CO          PART
                                                  0.0        0.0         2.040
                                              ------------------------------

  DEVICE      EFFICIENCIES             COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
            SOX      CO     PART      DOLLARS     SOX        CO          PART     SOX       CO         PART

    17      0.0      0.0    0.990    31211.47     0.0        0.0         0.020    0.0       0.0        42.34



                                      CONTROL COST-EFFECTIVENESS REPORT

            SIC=  2040     SITE=   141                ORIGINAL EMISSIONS
                                                  SOX        CO          PART
                                                  0.0        0.0         2.480
                                              ------------------------------

  DEVICE      EFFICIENCIES             COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
            SOX      CO     PART      DOLLARS     SOX        CO          PART     SOX       CO         PART

    17      0.0      0.0    0.990    33701.07     0.0        0.0         0.025    0.0       0.0        37.61



                                      CONTROL COST-EFFECTIVENESS REPORT

            SIC=  2040     SITE=   151                ORIGINAL EMISSIONS
                                                  SOX        CO          PART
                                                  0.0        0.0         2.480
                                              ------------------------------

  DEVICE      EFFICIENCIES             COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
            SOX      CO     PART      DOLLARS     SOX        CO          PART     SOX       CO         PART

    17      0.0      0.0    0.990    33701.07     0.0        0.0         0.025    0.0       0.0        37.61
```

```
                         CONTROL COST-EFFECTIVENESS REPORT

        SIC=  2040     SITE=   161              ORIGINAL EMISSIONS
                                             SOX        CO         PART
                                             0.0        0.0        4.960
                                          --------------------------------

DEVICE      EFFICIENCIES          COST        CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
         SOX      CO     PART    DOLLARS     SOX        CO         PART      SOX       CO        PART

  17     0.0      0.0    0.990   47588.44    0.0        0.0        0.050     0.0       0.0       26.55




                         CONTROL COST-EFFECTIVENESS REPORT

        SIC=  2040     SITE=   171              ORIGINAL EMISSIONS
                                             SOX        CO         PART
                                             0.0        0.0        1.490
                                          --------------------------------

DEVICE      EFFICIENCIES          COST        CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
         SOX      CO     PART    DOLLARS     SOX        CO         PART      SOX       CO        PART

  17     0.0      0.0    0.990   14092.22    0.0        0.0        0.015     0.0       0.0       26.17




                         CONTROL COST-EFFECTIVENESS REPORT

        SIC=  2040     SITE=   181              ORIGINAL EMISSIONS
                                             SOX        CO         PART
                                             0.0        0.0        3.480
                                          --------------------------------

DEVICE      EFFICIENCIES          COST        CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
         SOX      CO     PART    DOLLARS     SOX        CO         PART      SOX       CO        PART

  17     0.0      0.0    0.990   39251.65    0.0        0.0        0.035     0.0       0.0       31.21
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

         SIC=  2040     SITE=  191                ORIGINAL EMISSIONS
                                                SOX       CO        PART
                                                0.0       0.0       3.780

DEVICE      EFFICIENCIES           COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
         SOX       CO     PART    DOLLARS     SOX       CO        PART        SOX       CO        PART

  17     0.0       0.0    0.990   40931.76    0.0       0.0       0.038       0.0       0.0       29.97



                              CONTROL COST-EFFECTIVENESS REPORT

         SIC=  2046     SITE=  2200               ORIGINAL EMISSIONS
                                                SOX       CO        PART
                                                18.790    0.0       10.800

DEVICE      EFFICIENCIES           COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
         SOX       CO     PART    DOLLARS     SOX       CO        PART        SOX       CO        PART

   7     0.0       0.0    0.780   11618.70    18.790    0.0       2.376       0.0       0.0        3.78
   8     0.0       0.0    0.500    9749.65    18.790    0.0       5.400       0.0       0.0        4.95
  10     0.0       0.0    0.960   29295.00    18.790    0.0       0.432       0.0       0.0        7.74
  11     0.0       0.0    0.920   25483.16    18.790    0.0       0.864       0.0       0.0        7.03
  12     0.0       0.0    0.860   21688.56    18.790    0.0       1.512       0.0       0.0        6.40
  27     0.493     0.0    0.499  109799.38     9.520    0.0       5.415      32.45      0.0       55.86
  28     0.747     0.0    0.499  196672.00     4.760    0.0       5.415      38.41      0.0      100.95
  29     0.882     0.0    0.533  294478.13     2.216    0.0       5.041      48.68      0.0      140.10
  30     0.704     0.0    0.982  373182.44     5.560    0.0       0.192      77.28      0.0       96.39
  31     0.852     0.0    0.982  409086.75     2.780    0.0       0.192      70.01      0.0      105.66
  32     0.926     0.0    0.982  480895.75     1.390    0.0       0.192      75.72      0.0      124.21
  33     1.000     0.0    0.997  700665.75     0.0      0.0       0.031     102.16      0.0      178.25
```

CONTROL COST-EFFECTIVENESS REPORT

SIC= 2082 SITE= 800

ORIGINAL EMISSIONS SOX	CO	PART
1.580	0.0	2.01

DEVICE	EFFICIENCIES SOX	CO	PART	COST DOLLARS	CONTROLLED EMISSIONS SOX	CO	PART	EFFECTIVENESS ($/TON) SOX	CO	PART
7	0.0	0.0	0.850	9614.65	1.580	0.0	0.301	0.0	0.0	15.42
8	0.0	0.0	0.700	8650.35	1.580	0.0	0.603	0.0	0.0	16.84
10	0.0	0.0	0.980	27169.98	1.580	0.0	0.040	0.0	0.0	37.79
11	0.0	0.0	0.950	23238.82	1.580	0.0	0.100	0.0	0.0	33.34
12	0.0	0.0	0.900	19474.56	1.580	0.0	0.201	0.0	0.0	29.49
27	0.310	0.0	0.383	23203.69	1.091	0.0	1.241	129.98	0.0	82.66
28	0.655	0.0	0.383	33158.31	0.545	0.0	1.241	87.81	0.0	118.12
29	0.839	0.0	0.425	44365.81	0.254	0.0	1.155	91.66	0.0	142.22
30	0.612	0.0	0.979	50491.19	0.613	0.0	0.042	143.12	0.0	70.31
31	0.806	0.0	0.979	54452.56	0.307	0.0	0.042	117.17	0.0	75.92
32	0.903	0.0	0.979	62375.25	0.153	0.0	0.042	119.79	0.0	86.86
33	1.000	0.0	0.997	74199.00	0.0	0.0	0.006	128.66	0.0	101.45

CONTROL COST-EFFECTIVENESS REPORT

SIC= 2082 SITE= 810

ORIGINAL EMISSIONS SOX	CO	PART
17.900	0.0	2.290

DEVICE	EFFICIENCIES SOX	CO	PART	COST DOLLARS	CONTROLLED EMISSIONS SOX	CO	PART	EFFECTIVENESS ($/TON) SOX	CO	PART
10	0.0	0.0	0.960	82583.38	17.900	0.0	0.092	0.0	0.0	102.92
11	0.0	0.0	0.900	70549.13	17.900	0.0	0.229	0.0	0.0	93.78
12	0.0	0.0	0.800	60969.24	17.900	0.0	0.458	0.0	0.0	91.18
27	0.402	0.0	0.468	123436.44	10.703	0.0	1.217	46.99	0.0	315.30
28	0.701	0.0	0.468	221098.25	5.351	0.0	1.217	48.27	0.0	564.76
29	0.861	0.0	0.505	331051.13	2.491	0.0	1.133	58.86	0.0	784.23
30	0.651	0.0	0.981	420033.13	6.251	0.0	0.043	98.78	0.0	512.20
31	0.825	0.0	0.981	450397.13	3.125	0.0	0.043	85.37	0.0	561.42
32	0.913	0.0	0.981	541125.13	1.563	0.0	0.043	90.75	0.0	659.86
33	1.000	0.0	0.997	788188.13	0.0	0.0	0.007	120.64	0.0	945.83

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                          CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2082      SITE=   82C                   ORIGINAL EMISSIONS
                                                  SOX       CO          PART
                                                 3.170      0.0         4.000
                                              ------------------------------

DEVICE       EFFICIENCIES               COST       CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
          SOX       CO      PART       DOLLARS     SOX       CO          PART       SOX         CO          PART

   7      0.0       0.0     0.850     10707.07    3.170      0.0         0.600       0.0         0.0         8.63
   8      0.0       0.0     0.700      9505.89    3.170      0.0         1.200       0.0         0.0         9.30
  10      0.0       0.0     0.980     28530.80    3.170      0.0         0.080       0.0         0.0        19.94
  11      0.0       0.0     0.950     24419.00    3.170      0.0         0.200       0.0         0.0        17.61
  12      0.0       0.0     0.900     20501.54    3.170      0.0         0.400       0.0         0.0        15.60
  27      0.488     0.0     0.538     34553.44    1.625      0.0         1.848      61.25        0.0        43.99
  28      0.744     0.0     0.538     49377.13    0.812      0.0         1.848      57.38        0.0        62.86
  29      0.881     0.0     0.570     66066.56    0.378      0.0         1.720      64.83        0.0        79.40
  30      0.712     0.0     0.984     75209.88    0.913      0.0         0.063      91.32        0.0        52.34
  31      0.856     0.0     0.984     81108.81    0.457      0.0         0.063      81.90        0.0        56.45
  32      0.928     0.0     0.984     92906.69    0.228      0.0         0.063      86.53        0.0        64.66
  33      1.000     0.0     0.998    110513.81    0.0        0.0         0.009      95.51        0.0        75.87
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                          CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2800      SITE=   400                   ORIGINAL EMISSIONS
                                                  SOX       CO          PART
                                                10.230      0.0         1.982
                                              ------------------------------

DEVICE       EFFICIENCIES               COST       CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
          SOX       CO      PART       DOLLARS     SOX       CO          PART       SOX         CO          PART

  10      0.0       0.0     0.960     24857.31   10.230      0.0         0.079       0.0         0.0        35.93
  11      0.0       0.0     0.900     21471.73   10.230      0.0         0.198       0.0         0.0        33.01
  12      0.0       0.0     0.800     18064.92   10.230      0.0         0.396       0.0         0.0        31.25
  27      0.153     0.0     0.303   -114659.00**  8.664      0.0         1.380    -200.54        0.0      -523.27
  28      0.577     0.0     0.303    -35603.94    4.332      0.0         1.380     -16.54        0.0      -162.49
  29      0.803     0.0     0.351     53401.25    2.017      0.0         1.285      17.81        0.0       210.37
  30      0.505     0.0     0.975    124382.69**  5.060      0.0         0.049      65.91        0.0       176.48
  31      0.753     0.0     0.975    157056.44    2.530      0.0         0.049      55.88        0.0       222.84
  32      0.876     0.0     0.975    222403.69    1.265      0.0         0.049      67.97        0.0       315.56
  33      1.000     0.0     0.996    422396.44    0.0        0.0         0.008     113.12        0.0       586.79
```

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                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2800       SITE=   410              ORIGINAL EMISSIONS
                                                   SOX        CO         PART
                                                 26.740      0.0         5.120
                                                ------------------------------

DEVICE       EFFICIENCIES              COST       CONTROLLED EMISSIONS                EFFECTIVENESS ($/TON)
          SOX       CO      PART      DOLLARS     SOX        CO         PART          SOX        CO         PART

   10     0.0       0.0     0.960     93125.63   26.740      0.0        0.205          0.0        0.0        51.91
   11     0.0       0.0     0.900     78628.81   26.740      0.0        0.512          0.0        0.0        46.75
   12     0.0       0.0     0.800     67246.88   26.740      0.0        1.024          0.0        0.0        44.98
   27     0.402     0.0     0.361    184388.00   15.988      0.0        3.273         46.98       0.0       273.58
   28     0.701     0.0     0.361    330275.00    7.994      0.0        3.273         48.27       0.0       490.03
   29     0.861     0.0     0.405    494522.00    3.721      0.0        3.048         58.86       0.0       653.79
   30     0.651     0.0     0.977    626974.00    9.337      0.0        0.116         98.70       0.0       343.30
   31     0.825     0.0     0.977    687269.00    4.668      0.0        0.116         85.31       0.0       376.31
   32     0.913     0.0     0.977    807860.00    2.334      0.0        0.116         90.69       0.0       442.34
   33     1.000     0.0     0.996   1176921.00    0.0        0.0        0.019        120.58       0.0       632.06
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                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2800       SITE=   420              ORIGINAL EMISSIONS
                                                   SOX        CO         PART
                                                  2.630      0.0         2.360
                                                ------------------------------

DEVICE       EFFICIENCIES              COST       CONTROLLED EMISSIONS                EFFECTIVENESS ($/TON)
          SOX       CO      PART      DOLLARS     SOX        CO         PART          SOX        CO         PART

    7     0.0       0.0     0.800     11311.08    2.630      0.0        0.472          0.0        0.0        16.41
   10     0.0       0.0     0.980     29741.70    2.630      0.0        0.047          0.0        0.0        35.23
   11     0.0       0.0     0.940     25177.82    2.630      0.0        0.142          0.0        0.0        31.09
   12     0.0       0.0     0.880     20968.07    2.630      0.0        0.283          0.0        0.0        27.66
   27     0.306     0.0     0.384     38841.06    1.826      0.0        1.454        132.37       0.0       117.46
   28     0.653     0.0     0.384     55504.19    0.913      0.0        1.454         88.57       0.0       167.85
   29     0.838     0.0     0.426     74264.56    0.425      0.0        1.354         92.28       0.0       202.20
   30     0.610     0.0     0.979     84170.19    1.027      0.0        0.050        143.84       0.0        99.82
   31     0.805     0.0     0.979     90801.13    0.513      0.0        0.050        117.53       0.0       107.68
   32     0.902     0.0     0.979    104063.00    0.257      0.0        0.050        120.13       0.0       123.41
   33     1.000     0.0     0.997    123854.94    0.0        0.0        0.007        129.02       0.0       144.23
```

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                                  CONTROL COST-EFFECTIVENESS REPORT

         SIC=  2890       SITE=   430                ORIGINAL EMISSIONS
                                                   SOX       CO         PART
                                                  7.820     0.0        5.999
                                              ----------------------------------

 DEVICE       EFFICIENCIES               COST          CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX       CO      PART        DOLLARS      SOX       CO         PART        SOX        CO          PART

    7     0.0       0.0     0.800      25518.80     7.820     0.0        1.198        0.0        0.0        14.59
   10     0.0       0.0     0.980      64800.32     7.820     0.0        0.120        0.0        0.0        30.24
   11     0.0       0.0     0.940      57459.86     7.820     0.0        0.359        0.0        0.0        27.96
   12     0.0       0.0     0.880      51208.43     7.820     0.0        0.719        0.0        0.0        26.62
   27     0.403     0.0     0.344      53878.06     4.672     0.0        3.932       46.88       0.0        71.74
   28     0.701     0.0     0.344      96506.00     2.336     0.0        3.932       48.21       0.0       128.49
   29     0.861     0.0     0.389     144499.13     1.087     0.0        3.661       58.80       0.0       169.99
   30     0.651     0.0     0.977     204774.13     2.728     0.0        0.140      110.18       0.0        95.90
   31     0.826     0.0     0.977     204774.13     1.364     0.0        0.140       86.90       0.0        95.90
   32     0.913     0.0     0.977     240010.56     0.682     0.0        0.140       92.12       0.0       112.40
   33     1.000     0.0     0.996     347850.31     0.0       0.0        0.022      121.87       0.0       159.69


                                  CONTROL COST-EFFECTIVENESS REPORT

         SIC=  2819       SITE=   301                ORIGINAL EMISSIONS
                                                   SOX       CO         PART
                                                  12.000    0.0        1.900
                                              ----------------------------------

 DEVICE       EFFICIENCIES               COST          CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX       CO      PART        DOLLARS      SOX       CO         PART        SOX        CO          PART

   18     0.0       0.0     0.900      32660.35    12.000     0.0        0.190        0.0        0.0        52.33
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

        SIC=  2819     SITE=  330                  ORIGINAL EMISSIONS
                                                 SOX        CO        PART
                                                31.690      0.0      19.260
                                            ------------------------------

DEVICE      EFFICIENCIES              COST         CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
          SOX      CO      PART      DOLLARS      SOX        CO        PART          SOX        CO        PART

   7     0.0      0.0     0.800     88079.44    31.690      0.0       3.852          0.0        0.0       15.66
  10     0.0      0.0     0.980    260415.06    31.690      0.0       0.385          0.0        0.0       37.80
  11     0.0      0.0     0.950    199668.19    31.690      0.0       0.963          0.0        0.0       29.90
  12     0.0      0.0     0.900    152705.88    31.690      0.0       1.926          0.0        0.0       24.14
  27     0.455    0.0     0.490    199164.00    17.269      0.0       9.822         37.84       0.0       57.81
  28     0.728    0.0     0.490    356741.00     8.634      0.0       9.822         42.39       0.0      103.55
  29     0.873    0.0     0.525    534151.00     4.019      0.0       9.144         52.89       0.0      144.67
  30     0.682    0.0     0.982    676656.00    10.085      0.0       0.349         85.81       0.0       98.03
  31     0.841    0.0     0.982    741783.00     5.043      0.0       0.349         76.27       0.0      107.47
  32     0.920    0.0     0.982    872037.00     2.521      0.0       0.349         81.91       0.0      126.34
  33     1.000    0.0     0.997   1270674.00     0.0        0.0       0.056        109.85       0.0      181.28
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

        SIC=  2819     SITE=  340                  ORIGINAL EMISSIONS
                                                 SOX        CO        PART
                                                20.360      0.0       3.900
                                            ------------------------------

DEVICE      EFFICIENCIES              COST         CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
          SOX      CO      PART      DOLLARS      SOX        CO        PART          SOX        CO        PART

  10     0.0      0.0     0.960    168628.81    20.360      0.0       0.156          0.0        0.0      123.40
  11     0.0      0.0     0.900    132182.56    20.360      0.0       0.390          0.0        0.0      103.17
  12     0.0      0.0     0.800    102008.13    20.360      0.0       0.780          0.0        0.0       89.58
  27     0.385    0.0     0.269    183801.06    12.529      0.0       2.850         64.31       0.0      479.77
  28     0.692    0.0     0.269    298129.38     6.265      0.0       2.850         57.95       0.0      778.19
  29     0.857    0.0     0.320    426849.38     2.916      0.0       2.654         67.04       0.0      938.43
  30     0.641    0.0     0.974    530163.38     7.317      0.0       0.101        111.36       0.0      382.37
  31     0.820    0.0     0.974    577416.38     3.659      0.0       0.101         94.72       0.0      416.45
  32     0.910    0.0     0.974    671921.38     1.829      0.0       0.101         99.34       0.0      484.61
  33     1.000    0.0     0.996    961150.38     0.0        0.0       0.016        129.34       0.0      678.31
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2819     SITE=  1601                ORIGINAL EMISSIONS
                                                  SOX       CO        PART
                                                  0.0       0.0       21.900
                                              ---------------------------------

 DEVICE      EFFICIENCIES             COST       CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
          SOX       CO      PART     DOLLARS     SOX       CO        PART      SOX        CO          PART

    1     0.0       0.0     0.980   123057.75    0.0       0.0       0.438     0.0        0.0         15.71
    2     0.0       0.0     0.800    57220.84    0.0       0.0       4.380     0.0        0.0          8.95


                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2819     SITE=  1602                ORIGINAL EMISSIONS
                                                  SOX       CO        PART
                                                  0.0       0.0       48.500
                                              ---------------------------------

 DEVICE      EFFICIENCIES             COST       CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
          SOX       CO      PART     DOLLARS     SOX       CO        PART      SOX        CO          PART

    1     0.0       0.0     0.980   109595.81    0.0       0.0       0.970     0.0        0.0          6.32
    2     0.0       0.0     0.800    57167.27    0.0       0.0       9.700     0.0        0.0          4.04


                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2819     SITE=  2601                ORIGINAL EMISSIONS
                                                  SOX       CO        PART
                                                  0.0       0.0       8.000
                                              ---------------------------------

 DEVICE      EFFICIENCIES             COST       CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
          SOX       CO      PART     DOLLARS     SOX       CO        PART      SOX        CO          PART

   10     0.0       0.0     0.950    93917.38    0.0       0.0       0.400     0.0        0.0         33.86
   11     0.0       0.0     0.900    78819.06    0.0       0.0       0.800     0.0        0.0         29.99
   12     0.0       0.0     0.800    66387.06    0.0       0.0       1.600     0.0        0.0         28.42
   17     0.0       0.0     0.990    69371.94    0.0       0.0       0.080     0.0        0.0         24.00
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

           SIC=  2822     SITE=  1900                      ORIGINAL EMISSIONS
                                                      SOX        CO          PART
                                                     2.120       0.0         4.260
                                                   --------------------------------

DEVICE        EFFICIENCIES             COST         CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
           SOX       CO     PART      DOLLARS       SOX        CO          PART        SOX        CO          PART

    7      0.0      0.0     0.850      9694.13     2.120       0.0         0.639       0.0        0.0          7.33
    8      0.0      0.0     0.700      8743.75     2.120       0.0         1.278       0.0        0.0          8.03
    9      0.0      0.0     0.600      7703.40     2.120       0.0         1.704       0.0        0.0          8.26
   10      0.0      0.0     0.980     27055.86     2.120       0.0         0.085       0.0        0.0         17.76
   11      0.0      0.0     0.950     23324.16     2.120       0.0         0.213       0.0        0.0         15.79
   12      0.0      0.0     0.900     19670.48     2.120       0.0         0.426       0.0        0.0         14.06
   27      0.515    0.0     0.726     21858.54     1.028       0.0         1.169      54.82       0.0         19.37
   28      0.758    0.0     0.726     31236.10     0.514       0.0         1.169      53.28       0.0         27.69
   29      0.887    0.0     0.745     41793.85     0.239       0.0         1.088      60.88       0.0         36.10
   30      0.727    0.0     0.991     47680.16     0.578       0.0         0.040      84.71       0.0         30.96
   31      0.864    0.0     0.991     51411.85     0.289       0.0         0.040      76.92       0.0         33.38
   32      0.932    0.0     0.991     58875.22     0.144       0.0         0.040      81.65       0.0         38.22
   33      1.000    0.0     0.999     70013.56     0.0         0.0         0.006      90.48       0.0         45.09
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

           SIC=  2822     SITE=  1901                      ORIGINAL EMISSIONS
                                                      SOX        CO          PART
                                                      0.0        0.0         1.450
                                                   --------------------------------

DEVICE        EFFICIENCIES             COST         CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
           SOX       CO     PART      DOLLARS       SOX        CO          PART        SOX        CO          PART

    7      0.0      0.0     0.800     25448.27     0.0         0.0         0.290       0.0        0.0         60.10
    8      0.0      0.0     0.650     22043.36     0.0         0.0         0.507       0.0        0.0         64.08
   17      0.0      0.0     0.990     50293.12     0.0         0.0         0.015       0.0        0.0         95.99
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2841      SITE=  2300               ORIGINAL EMISSIONS
                                                 SOX        CO         PART
                                                 2.380      0.0        0.760
                                               ----------------------------------

DEVICE     EFFICIENCIES              COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX       CO     PART     DOLLARS     SOX        CO         PART      SOX        CO         PART

   7     0.0       0.0     0.500    11118.82    2.380      0.0        0.380     0.0        0.0        80.16
  10     0.0       0.0     0.950    29028.42    2.380      0.0        0.038     0.0        0.0       110.15
  11     0.0       0.0     0.900    24581.28    2.380      0.0        0.076     0.0        0.0        98.46
  12     0.0       0.0     0.850    20441.34    2.380      0.0        0.114     0.0        0.0        86.69
  27     0.307     0.0     0.383    35057.88    1.648      0.0        0.469   131.26       0.0       329.74
  28     0.654     0.0     0.383    50098.00    0.824      0.0        0.469    88.22       0.0       471.20
  29     0.839     0.0     0.426    67031.06    0.384      0.0        0.436    91.99       0.0       567.49
  30     0.611     0.0     0.979    76264.06    0.927      0.0        0.016   143.78       0.0       280.85
  31     0.805     0.0     0.979    82249.13    0.463      0.0        0.016   117.57       0.0       302.89
  32     0.903     0.0     0.979    94219.25    0.232      0.0        0.016   120.16       0.0       346.97
  33     1.000     0.0     0.997   112083.44    0.0        0.0        0.002   129.02       0.0       405.30
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2851      SITE=  1701               ORIGINAL EMISSIONS
                                                 SOX        CO         PART
                                                 0.0        0.0        2.400
                                               ----------------------------------

DEVICE     EFFICIENCIES              COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX       CO     PART     DOLLARS     SOX        CO         PART      SOX        CO         PART

   2     0.0       0.0     0.900    13948.27    0.0        0.0        0.240     0.0        0.0        17.69
   3     0.0       0.0     0.750    12507.42    0.0        0.0        0.600     0.0        0.0        19.04
  17     0.0       0.0     0.990    19181.67    0.0        0.0        0.024     0.0        0.0        22.12
```

```
                                CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2911      SITE=    601                   ORIGINAL EMISSIONS
                                                    SOX        CO          PART
                                                    0.0     206.000       0.150
                                               ------------------------------

 DEVICE       EFFICIENCIES              COST        CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
           SOX        CO     PART      DOLLARS     SOX        CO          PART       SOX      CO          PART

   49      0.0       0.980   0.0     -998894.06    0.0       4.120       0.150       0.0    -13.56        0.0


                                CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2911      SITE=    611                   ORIGINAL EMISSIONS
                                                    SOX        CO          PART
                                                    0.0     521.000       0.120
                                               ------------------------------

 DEVICE       EFFICIENCIES              COST        CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
           SOX        CO     PART      DOLLARS     SOX        CO          PART       SOX      CO          PART

   49      0.0       0.980   0.0    -2770966.00    0.0      10.420       0.120       0.0    -14.87        0.0


                                CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2911      SITE=    621                   ORIGINAL EMISSIONS
                                                    SOX        CO          PART
                                                    0.0      82.400       0.020
                                               ------------------------------

 DEVICE       EFFICIENCIES              COST        CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
           SOX        CO     PART      DOLLARS     SOX        CO          PART       SOX      CO          PART

   21      0.0       0.900   0.0      182241.25    0.0       8.240       0.020       0.0      6.73        0.0
```

```
                                   CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2911      SITE=   630                ORIGINAL EMISSIONS
                                                    SOX       CO         PART
                                                   0.870     0.0        0.070
                                            --------------------------------

DEVICE       EFFICIENCIES               COST       CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
           SOX      CO     PART        DOLLARS     SOX         CO          PART     SOX        CO         PART

  34      1.000    0.0     0.876      54400.00    0.0         0.0         0.009    171.31      0.0     2429.34

                                   CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2911      SITE=   631                ORIGINAL EMISSIONS
                                                    SOX       CO         PART
                                                   0.0      89.300      0.0
                                            --------------------------------

DEVICE       EFFICIENCIES               COST       CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
           SOX      CO     PART        DOLLARS     SOX         CO          PART     SOX        CO         PART

  49      0.0     0.980    0.0     -285077.00     0.0         1.786       0.0       0.0       -8.92       0.0

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                                   CONTROL COST-EFFECTIVENESS REPORT

          SIC=  2951      SITE=  1501                ORIGINAL EMISSIONS
                                                    SOX       CO         PART
                                                   0.0       0.0        0.970
                                            --------------------------------

DEVICE       EFFICIENCIES               COST       CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
           SOX      CO     PART        DOLLARS     SOX         CO          PART     SOX        CO         PART

   1      0.0      0.0     0.980       5479.63    0.0         0.0         0.019     0.0        0.0       15.79
   2      0.0      0.0     0.940       4306.84    0.0         0.0         0.058     0.0        0.0       12.94
   3      0.0      0.0     0.900       3287.57    0.0         0.0         0.097     0.0        0.0       10.32
   7      0.0      0.0     0.922       3550.79    0.0         0.0         0.076     0.0        0.0       10.88
   8      0.0      0.0     0.880       3239.78    0.0         0.0         0.116     0.0        0.0       10.40
   9      0.0      0.0     0.800       2248.79    0.0         0.0         0.194     0.0        0.0        7.94
  17      0.0      0.0     0.990       6686.00    0.0         0.0         0.010     0.0        0.0       19.08
```

```
                                CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3200      SITE=  1400              ORIGINAL EMISSIONS
                                                 SOX        CO         PART
                                                6.950       0.0        8.700
                                               ------------------------------

 DEVICE       EFFICIENCIES             COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX      CO      PART       DOLLARS     SOX        CO         PART     SOX       CO         PART

    7     0.0      0.0     0.850     33582.60    6.950       0.0        1.305     0.0       0.0        12.44
    8     0.0      0.0     0.700     27357.32    6.950       0.0        2.610     0.0       0.0        12.31
    9     0.0      0.0     0.600     18678.25    6.950       0.0        3.480     0.0       0.0         9.83
   10     0.0      0.0     0.980    108196.44    6.950       0.0        0.174     0.0       0.0        34.77
   11     0.0      0.0     0.950     80683.94    6.950       0.0        0.435     0.0       0.0        26.75
   12     0.0      0.0     0.900     60962.56    6.950       0.0        0.870     0.0       0.0        21.33
   27     0.334    0.0     0.394     89025.00    4.632       0.0        5.269   105.22      0.0        71.08
   28     0.667    0.0     0.394    131290.94    2.316       0.0        5.269    77.62      0.0       104.83
   29     0.845    0.0     0.436    178876.56    1.078       0.0        4.905    83.46      0.0       129.15
   30     0.625    0.0     0.979    201392.44    2.605       0.0        0.180   126.97      0.0        64.76
   31     0.813    0.0     0.979    218211.81    1.302       0.0        0.180   105.86      0.0        70.17
   32     0.906    0.0     0.979    251850.44    0.651       0.0        0.180   109.54      0.0        80.99
   33     1.000    0.0     0.997    302052.88    0.0         0.0        0.026   119.07      0.0        95.41



                                CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3210      SITE=  1201              ORIGINAL EMISSIONS
                                                 SOX        CO         PART
                                                 0.0        0.0        3.500
                                               ------------------------------

 DEVICE       EFFICIENCIES             COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX      CO      PART       DOLLARS     SOX        CO         PART     SOX       CO         PART

    2     0.0      0.0     0.943     34139.44    0.0         0.0        0.200     0.0       0.0        28.34
    3     0.0      0.0     0.850     29613.70    0.0         0.0        0.525     0.0       0.0        27.27
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

             SIC=  3210     SITE=  1210              ORIGINAL EMISSIONS
                                                  SOX       CO          PART
                                                 2.930      0.0         0.370
                                              --------------------------------

 DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
          SOX       CO     PART       DOLLARS     SOX       CO          PART        SOX       CO        PART

   34    1.000     0.0    0.808    348783.00     0.0       0.0         0.071      326.13      0.0     3194.56


                              CONTROL COST-EFFECTIVENESS REPORT

             SIC=  3241     SITE=  1001              ORIGINAL EMISSIONS
                                                  SOX       CO          PART
                                                  0.0       0.0         2.790
                                              --------------------------------

 DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
          SOX       CO     PART       DOLLARS     SOX       CO          PART        SOX       CO        PART

   10     0.0      0.0    0.850    150869.50     0.0       0.0         0.419        0.0       0.0      174.30
   11     0.0      0.0    0.700    130261.19     0.0       0.0         0.837        0.0       0.0      182.73


                              CONTROL COST-EFFECTIVENESS REPORT

             SIC=  3241     SITE=  1011              ORIGINAL EMISSIONS
                                                  SOX       CO          PART
                                                  0.0       0.0         5.800
                                              --------------------------------

 DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
          SOX       CO     PART       DOLLARS     SOX       CO          PART        SOX       CO        PART

   10     0.0      0.0    0.850    199864.88     0.0       0.0         0.870        0.0       0.0      111.07
   11     0.0      0.0    0.700    167141.44     0.0       0.0         1.740        0.0       0.0      112.79
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

         SIC=  3250      SITE=  2101            ORIGINAL EMISSIONS
                                               SOX       CO        PART
                                               0.0       0.0       3.040
                                              ------------------------------

DEVICE       EFFICIENCIES             COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX       CO     PART      DOLLARS     SOX       CO        PART        SOX       CO        PART

  2       0.0      0.0     0.900    25172.85     0.0       0.0       0.304       0.0       0.0       25.21
  3       0.0      0.0     0.800    22529.18     0.0       0.0       0.608       0.0       0.0       25.38
  6       0.0      0.0     0.600    13802.52     0.0       0.0       1.216       0.0       0.0       20.73
  7       0.0      0.0     0.850    13092.32     0.0       0.0       0.456       0.0       0.0       13.88
  8       0.0      0.0     0.770    10928.02     0.0       0.0       0.699       0.0       0.0       12.79
  9       0.0      0.0     0.700     8289.94     0.0       0.0       0.912       0.0       0.0       10.67
 17       0.0      0.0     0.990    44520.82     0.0       0.0       0.030       0.0       0.0       40.53


                              CONTROL COST-EFFECTIVENESS REPORT

         SIC=  3295      SITE=   501            ORIGINAL EMISSIONS
                                               SOX       CO        PART
                                               0.0       0.0       1.200
                                              ------------------------------

DEVICE       EFFICIENCIES             COST       CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX       CO     PART      DOLLARS     SOX       CO        PART        SOX       CO        PART

  1       0.0      0.0     0.900    16708.63     0.0       0.0       0.120       0.0       0.0       42.39
  2       0.0      0.0     0.800    11837.50     0.0       0.0       0.240       0.0       0.0       33.78
  3       0.0      0.0     0.600     9913.18     0.0       0.0       0.480       0.0       0.0       37.72
  7       0.0      0.0     0.600     8695.62     0.0       0.0       0.480       0.0       0.0       33.09
 17       0.0      0.0     0.990    18241.68     0.0       0.0       0.012       0.0       0.0       42.07
```

```
                         CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3295      SITE=    511                 ORIGINAL EMISSIONS
                                                  SOX        CO         PART
                                                  0.0        0.0       19.180
                                                ------------------------------

DEVICE      EFFICIENCIES               COST        CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX       CO      PART      DOLLARS     SOX        CO         PART       SOX        CO         PART

   1      0.0       0.0     0.960    51296.09     0.0        0.0        0.767      0.0        0.0        7.63
   2      0.0       0.0     0.900    29741.12     0.0        0.0        1.918      0.0        0.0        4.72
   3      0.0       0.0     0.800    23200.64     0.0        0.0        3.836      0.0        0.0        4.14
   7      0.0       0.0     0.850    23233.31     0.0        0.0        2.877      0.0        0.0        3.90
   8      0.0       0.0     0.750    19006.35     0.0        0.0        4.795      0.0        0.0        3.62
   9      0.0       0.0     0.600    13693.96     0.0        0.0        7.672      0.0        0.0        3.26
  17      0.0       0.0     0.990    43676.35     0.0        0.0        0.192      0.0        0.0        6.30
```

```
                         CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3295      SITE=    521                 ORIGINAL EMISSIONS
                                                  SOX        CO         PART
                                                  0.0        0.0        8.220
                                                ------------------------------

DEVICE      EFFICIENCIES               COST        CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
          SOX       CO      PART      DOLLARS     SOX        CO         PART       SOX        CO         PART

   1      0.0       0.0     0.960    26746.19     0.0        0.0        0.329      0.0        0.0        9.29
   2      0.0       0.0     0.900    16436.27     0.0        0.0        0.822      0.0        0.0        6.09
   3      0.0       0.0     0.800    13384.39     0.0        0.0        1.644      0.0        0.0        5.58
   7      0.0       0.0     0.850    12483.48     0.0        0.0        1.233      0.0        0.0        4.89
   8      0.0       0.0     0.750    10539.49     0.0        0.0        2.055      0.0        0.0        4.68
   9      0.0       0.0     0.600     8059.79     0.0        0.0        3.288      0.0        0.0        4.48
  17      0.0       0.0     0.990    24669.50     0.0        0.0        0.082      0.0        0.0        8.31
```

```
                                    CONTROL COST-EFFECTIVENESS REPORT

            SIC=  3295      SITE=   531                    ORIGINAL EMISSIONS
                                                       SOX        CO        PART
                                                       0.0        0.0      13.700
                                                  ---------------------------------

 DEVICE       EFFICIENCIES                 COST       CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
            SOX       CO      PART       DOLLARS     SOX        CO        PART         SOX        CO        PART

    1       0.0       0.0     0.960     38418.42     0.0        0.0       0.548        0.0        0.0       8.00
    2       0.0       0.0     0.900     22920.96     0.0        0.0       1.370        0.0        0.0       5.09
    3       0.0       0.0     0.800     18167.79     0.0        0.0       2.740        0.0        0.0       4.54
    7       0.0       0.0     0.850     17686.01     0.0        0.0       2.055        0.0        0.0       4.16
    8       0.0       0.0     0.750     14640.54     0.0        0.0       3.425        0.0        0.0       3.90
    9       0.0       0.0     0.600     10787.25     0.0        0.0       5.480        0.0        0.0       3.60
   17       0.0       0.0     0.990     33948.24     0.0        0.0       0.137        0.0        0.0       6.86


                                    CONTROL COST-EFFECTIVENESS REPORT

            SIC=  3312      SITE=  1100                    ORIGINAL EMISSIONS
                                                       SOX        CO        PART
                                                       1.530      0.0       2.040
                                                  ---------------------------------

 DEVICE       EFFICIENCIES                 COST       CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
            SOX       CO      PART       DOLLARS     SOX        CO        PART         SOX        CO        PART

    7       0.0       0.0     0.850      8898.81     1.530      0.0       0.306        0.0        0.0      14.06
    8       0.0       0.0     0.700      8088.91     1.530      0.0       0.612        0.0        0.0      15.52
    9       0.0       0.0     0.600      7163.92     1.530      0.0       0.816        0.0        0.0      16.04
   10       0.0       0.0     0.980     26154.49     1.530      0.0       0.041        0.0        0.0      35.84
   11       0.0       0.0     0.950     22477.44     1.530      0.0       0.102        0.0        0.0      31.78
   12       0.0       0.0     0.900     18877.07     1.530      0.0       0.204        0.0        0.0      28.17
   33       1.000     0.0     0.949     68824.00     0.0        0.0       0.104      123.24       0.0      97.40
```

```
                                   CONTROL COST-EFFECTIVENESS REPORT

           SIC=  3312      SITE=  1110                ORIGINAL EMISSIONS
                                                    SOX       CO          PART
                                                   6.020      0.0         1.100
                                              ----------------------------------

  DEVICE         EFFICIENCIES             COST         CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
              SOX       CO      PART     DOLLARS      SOX        CO           PART     SOX        CO         PART

     34      1.000     0.0     0.445    381058.00     0.0        0.0          0.611   173.42      0.0      2134.76


                                   CONTROL COST-EFFECTIVENESS REPORT

           SIC=  3312      SITE=  1112                ORIGINAL EMISSIONS
                                                    SOX       CO          PART
                                                    0.0       0.0         0.740
                                              ----------------------------------

  DEVICE         EFFICIENCIES             COST         CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
              SOX       CO      PART     DOLLARS      SOX        CO           PART     SOX        CO         PART

     10      0.0       0.0     0.800    277982.38     0.0        0.0          0.148    0.0        0.0      1286.48
     11      0.0       0.0     0.650    225767.25     0.0        0.0          0.259    0.0        0.0      1285.95
     12      0.0       0.0     0.500    187663.13     0.0        0.0          0.370    0.0        0.0      1389.58


                                   CONTROL COST-EFFECTIVENESS REPORT

           SIC=  3312      SITE=  1113                ORIGINAL EMISSIONS
                                                    SOX       CO          PART
                                                   0.230      0.0         0.270
                                              ----------------------------------

  DEVICE         EFFICIENCIES             COST         CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
              SOX       CO      PART     DOLLARS      SOX        CO           PART     SOX        CO         PART

      1      0.650     0.0     0.980    256332.06    0.080       0.0          0.005  4697.52      0.0      2654.12
      2      0.650     0.0     0.800     99736.81    0.080       0.0          0.054  1827.77      0.0      1265.05
     10      0.0       0.0     0.950    171450.44    0.230       0.0          0.014    0.0        0.0      1831.30
     11      0.0       0.0     0.850    145640.06    0.230       0.0          0.041    0.0        0.0      1738.62
     12      0.0       0.0     0.750    126308.56    0.230       0.0          0.067    0.0        0.0      1708.89
     16      0.0       0.0     0.990    195014.19    0.230       0.0          0.003    0.0        0.0      1998.82
```

```
                        CONTROL COST-EFFECTIVENESS REPORT

        SIC=  3312      SITE=  1114           ORIGINAL EMISSIONS
                                           SOX        CO        PART
                                          0.250      0.0       2.840
                                       ------------------------------

DEVICE      EFFICIENCIES          COST     CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
         SOX      CO     PART    DOLLARS    SOX        CO        PART      SOX       CO        PART

  5      0.0      0.0    0.700   38015.29   0.250      0.0       0.852     0.0       0.0       52.39



                        CONTROL COST-EFFECTIVENESS REPORT

        SIC=  3323      SITE=   700           ORIGINAL EMISSIONS
                                           SOX        CO        PART
                                          5.140      0.0       6.900
                                       ------------------------------

DEVICE      EFFICIENCIES          COST     CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
         SOX      CO     PART    DOLLARS    SOX        CO        PART      SOX       CO        PART

  7      0.0      0.0    0.850   13689.09   5.140      0.0       1.035     0.0       0.0        6.39
  8      0.0      0.0    0.700   11834.44   5.140      0.0       2.070     0.0       0.0        6.71
 10      0.0      0.0    0.980   32721.25   5.140      0.0       0.138     0.0       0.0       13.26
 11      0.0      0.0    0.950   27787.03   5.140      0.0       0.345     0.0       0.0       11.61
 12      0.0      0.0    0.900   23262.34   5.140      0.0       0.690     0.0       0.0       10.26
 33      1.000    0.0    0.993  181111.19   0.0        0.0       0.048    96.54      0.0       72.42
```

```
                               CONTROL COST-EFFECTIVENESS REPORT

         SIC=  3323       SITE=   701                 ORIGINAL EMISSIONS
                                                  SOX        CO          PARROT
                                                  0.0        0.0         1.100
                                             ------------------------------

DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
         SOX        CO      PART     DOLLARS     SOX        CO          PART     SOX       CO         PART

   1     0.0        0.0     0.980   56616.50     0.0        0.0         0.022    0.0       0.0        143.89
   2     0.0        0.0     0.900   35696.19     0.0        0.0         0.110    0.0       0.0         98.79
   3     0.0        0.0     0.750   31149.89     0.0        0.0         0.275    0.0       0.0        103.45
   7     0.0        0.0     0.750   29248.92     0.0        0.0         0.275    0.0       0.0         97.13
   8     0.0        0.0     0.650   24976.88     0.0        0.0         0.385    0.0       0.0         95.71
   9     0.0        0.0     0.550   20127.18     0.0        0.0         0.495    0.0       0.0         91.15
  16     0.0        0.0     0.990   66718.38     0.0        0.0         0.011    0.0       0.0        167.85


                               CONTROL COST-EFFECTIVENESS REPORT

         SIC=  3323       SITE=   710                 ORIGINAL EMISSIONS
                                                  SOX        CO          PART
                                                  6.190      0.0         0.590
                                             ------------------------------

DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
         SOX        CO      PART     DOLLARS     SOX        CO          PART     SOX       CO         PART

   7     0.0        0.0     0.850   54073.24     6.190      0.0         0.088    0.0       0.0        295.41
   8     0.0        0.0     0.700   49297.18     6.190      0.0         0.177    0.0       0.0        327.02
  10     0.0        0.0     0.980   73877.25     6.190      0.0         0.012    0.0       0.0        350.06
  11     0.0        0.0     0.950   63880.59     6.190      0.0         0.030    0.0       0.0        312.25
  12     0.0        0.0     0.900   55811.13     6.190      0.0         0.059    0.0       0.0        287.96
  34     1.000      0.0     0.883  265165.00     0.0        0.0         0.069  117.36      0.0       1393.99
```

```
                                    CONTROL COST-EFFECTIVENESS REPORT

           SIC=  3323      SITE=    711                ORIGINAL EMISSIONS
                                                     SOX        CO          PART
                                                     0.0        0.0         0.600
                                                 ------------------------------

 DEVICE        EFFICIENCIES               COST       CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
           SOX        CO       PART      DOLLARS     SOX        CO          PART       SOX       CO          PART

    1      0.0        0.0      0.980    63080.36     0.0        0.0         0.012      0.0       0.0       293.92
    2      0.0        0.0      0.900    41828.61     0.0        0.0         0.060      0.0       0.0       212.22
    3      0.0        0.0      0.750    37409.96     0.0        0.0         0.150      0.0       0.0       227.76
    7      0.0        0.0      0.750    43122.28     0.0        0.0         0.150      0.0       0.0       262.54
    8      0.0        0.0      0.650    39544.76     0.0        0.0         0.210      0.0       0.0       277.80
    9      0.0        0.0      0.550    35514.18     0.0        0.0         0.270      0.0       0.0       294.85
   16      0.0        0.0      0.990    59691.71     0.0        0.0         0.006      0.0       0.0       275.32
```

```
                                    CONTROL COST-EFFECTIVENESS REPORT

           SIC=  3323      SITE=    721                ORIGINAL EMISSIONS
                                                     SOX        CO          PART
                                                     0.920      0.0         1.010
                                                 ------------------------------

 DEVICE        EFFICIENCIES               COST       CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
           SOX        CO       PART      DOLLARS     SOX        CO          PART       SOX       CO          PART

    1      0.0        0.0      0.980    15940.97     0.920      0.0         0.020      0.0       0.0        44.12
    2      0.0        0.0      0.900    10820.43     0.920      0.0         0.101      0.0       0.0        32.61
    3      0.0        0.0      0.750     9930.15     0.920      0.0         0.252      0.0       0.0        35.92
    7      0.0        0.0      0.750     7811.33     0.920      0.0         0.252      0.0       0.0        28.25
    8      0.0        0.0      0.650     7230.29     0.920      0.0         0.353      0.0       0.0        30.17
    9      0.0        0.0      0.550     6544.34     0.920      0.0         0.454      0.0       0.0        32.28
   16      0.0        0.0      0.990    14586.13     0.920      0.0         0.010      0.0       0.0        39.97
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3332     SITE=  2701               ORIGINAL EMISSIONS
                                                SOX        CO          PART
                                              203.000      0.0         0.310
                                             ---------------------------------

DEVICE      EFFICIENCIES            COST        CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
          SOX     CO    PART       DOLLARS     SOX       CO           PART       SOX        CO         PART

  2      0.800   0.0    0.200    123721.63    40.600     0.0          0.248      2.09       0.0      5467.14


                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3332     SITE=  2702               ORIGINAL EMISSIONS
                                                SOX        CO          PART
                                               1.320      0.0         0.260
                                             ---------------------------------

DEVICE      EFFICIENCIES            COST        CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
          SOX     CO    PART       DOLLARS     SOX       CO           PART       SOX        CO         PART

  2      0.800   0.0    0.200     96671.13     0.264     0.0          0.208     250.81      0.0      5093.31


                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3332     SITE=  2703               ORIGINAL EMISSIONS
                                                SOX        CO          PART
                                              28.200      0.0         0.020
                                             ---------------------------------

DEVICE      EFFICIENCIES            COST        CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
          SOX     CO    PART       DOLLARS     SOX       CO           PART       SOX        CO         PART

  2      0.800   0.0    0.200     22526.67     5.640     0.0          0.016      2.74       0.0     15429.22
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3711      SITE=  2500                ORIGINAL EMISSIONS
                                                     SOX       CO          PART
                                                     5.660     0.0         1.080
                                                   ----------------------------

DEVICE       EFFICIENCIES              COST         CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
          SOX        CO      PART      DOLLARS      SOX        CO          PART      SOX       CO          PART

    7     0.0        0.0     0.600     29944.66     5.660      0.0         0.432      0.0      0.0         126.61
   10     0.0        0.0     0.950     45263.36     5.660      0.0         0.054      0.0      0.0         120.87
   11     0.0        0.0     0.900     39417.15     5.660      0.0         0.108      0.0      0.0         111.10
   12     0.0        0.0     0.850     34329.80     5.660      0.0         0.162      0.0      0.0         102.46
   27     0.306      0.0     0.243     83567.19     3.929      0.0         0.818      0.0      0.0         873.34
   28     0.653      0.0     0.243    119418.19     1.964      0.0         0.818    132.26     0.0         873.34
   29     0.838      0.0     0.295    159781.50     0.914      0.0         0.818     88.53     0.0        1248.01
   30     0.610      0.0     0.974    179639.00     2.209      0.0         0.761     92.25     0.0        1374.18
   31     0.805      0.0     0.974    193905.56     1.105      0.0         0.028    142.62     0.0         467.83
   32     0.902      0.0     0.974    222438.69     0.552      0.0         0.028    116.62     0.0         504.98
   33     1.000      0.0     0.996    265021.44     0.0        0.0         0.004    119.31     0.0         579.29
                                                                                  128.28     0.0         674.86
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  3711      SITE=  2510                ORIGINAL EMISSIONS
                                                     SOX       CO          PART
                                                     4.740     0.0         6.050
                                                   ----------------------------

DEVICE       EFFICIENCIES              COST         CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
          SOX        CO      PART      DOLLARS      SOX        CO          PART      SOX       CO          PART

    7     0.0        0.0     0.850     12057.25     4.740      0.0         0.908      0.0      0.0           6.42
    8     0.0        0.0     0.700     10142.32     4.740      0.0         1.815      0.0      0.0           6.56
   10     0.0        0.0     0.980     38299.95     4.740      0.0         0.121      0.0      0.0          17.70
   11     0.0        0.0     0.950     31218.27     4.740      0.0         0.303      0.0      0.0          14.88
   12     0.0        0.0     0.900     25295.82     4.740      0.0         0.605      0.0      0.0          12.73
   27     0.307      0.0     0.382     69863.50     3.285      0.0         3.736    131.52     0.0          82.73
   28     0.654      0.0     0.382     99835.50     1.642      0.0         3.736     88.30     0.0         118.22
   29     0.839      0.0     0.425    133579.81     0.765      0.0         3.479     92.06     0.0         142.32
   30     0.610      0.0     0.979    153000.81     1.847      0.0         0.128    144.89     0.0          70.78
   31     0.805      0.0     0.979    164927.94     0.923      0.0         0.128    118.40     0.0          76.30
   32     0.903      0.0     0.979    188782.00     0.462      0.0         0.128    120.89     0.0          87.34
   33     1.000      0.0     0.997    224382.06     0.0        0.0         0.019    129.69     0.0         101.93
```

CONTROL COST-EFFECTIVENESS REPORT

SIC= 3742 SITE= 2400

ORIGINAL EMISSIONS		
SOX	CO	PART
1.600	0.0	1.220

DEVICE	EFFICIENCIES			COST	CONTROLLED EMISSIONS			EFFECTIVENESS ($/TON)		
	SOX	CO	PART	DOLLARS	SOX	CO	PART	SOX	CO	PART
7	0.0	0.0	0.800	8945.16	1.600	0.0	0.244	0.0	0.0	25.11
10	0.0	0.0	0.980	25817.06	1.600	0.0	0.024	0.0	0.0	59.16
11	0.0	0.0	0.940	22020.33	1.600	0.0	0.073	0.0	0.0	52.61
12	0.0	0.0	0.880	18383.30	1.600	0.0	0.146	0.0	0.0	46.91
27	0.306	0.0	0.368	23624.06	1.111	0.0	0.771	132.27	0.0	144.04
28	0.653	0.0	0.368	33759.00	0.555	0.0	0.771	88.54	0.0	205.84
29	0.838	0.0	0.412	45169.56	0.259	0.0	0.718	92.25	0.0	246.28
30	0.610	0.0	0.978	51369.69	0.625	0.0	0.026	144.28	0.0	117.91
31	0.805	0.0	0.978	55402.81	0.312	0.0	0.026	117.87	0.0	127.17
32	0.902	0.0	0.978	63469.00	0.156	0.0	0.026	120.43	0.0	145.68
33	1.000	0.0	0.997	75506.88	0.0	0.0	0.004	129.29	0.0	170.10

CONTROL COST-EFFECTIVENESS REPORT

SIC= 4911 SITE= 10

ORIGINAL EMISSIONS		
SOX	CO	PART
248.800	1.100	112.100

DEVICE	EFFICIENCIES			COST	CONTROLLED EMISSIONS			EFFECTIVENESS ($/TON)		
	SOX	CO	PART	DOLLARS	SOX	CO	PART	SOX	CO	PART
10	0.0	0.0	0.950	518997.50	248.800	1.100	5.605	0.0	0.0	13.35
11	0.0	0.0	0.850	429463.69	248.800	1.100	16.815	0.0	0.0	12.35
12	0.0	0.0	0.750	363506.88	248.800	1.100	28.025	0.0	0.0	11.85
27	0.396	0.146	0.362	1048844.00	150.277	0.939	71.532	29.17	17873.64	70.83
28	0.698	0.146	0.362	1597353.00	75.138	0.939	71.532	25.20	27220.93	107.88
29	0.859	0.205	0.406	3034834.00	34.978	0.874	66.599	38.89	36864.71	182.73
30	0.647	0.988	0.990	6467570.00	87.764	0.014	1.148	110.03	16308.71	159.70
31	0.824	0.988	0.990	6923434.00	43.882	0.014	1.148	92.57	17458.22	170.96
32	0.912	0.988	0.990	7884451.00	21.941	0.014	1.148	95.22	19881.53	194.69
33	1.000	1.000	0.998	10137274.00	0.0	0.0	0.275	111.63	25248.51	248.36
40	0.800	0.0	0.0	3041841.00	49.760	1.100	112.100	41.87	0.0	0.0
41	0.500	0.0	0.0	1419517.00	124.400	1.100	112.100	31.26	0.0	0.0
42	0.800	0.0	0.980	797983.38	49.760	1.100	2.242	10.98	0.0	19.90

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  4911      SITE=    20                 ORIGINAL EMISSIONS
                                                   SOX         CO          PART
                                                 116.950       0.0        15.320
                                             -----------------------------------

 DEVICE       EFFICIENCIES                 COST        CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
           SOX        CO      PART        DOLLARS      SOX         CO          PART       SOX         CO          PART

   10     0.0        0.0     0.750      602043.25    116.950      0.0         3.830       0.0         0.0       143.55
   27     0.341      0.0     0.296      466069.00     77.090      0.0        10.793      32.03        0.0       282.04
   28     0.670      0.0     0.296      747448.00     38.545      0.0        10.793      26.12        0.0       452.31
   29     0.847      0.0     0.344     1484854.00     17.943      0.0        10.048      41.09        0.0       771.68
   30     0.615      0.0     0.989     3247388.00     45.022      0.0         0.173     123.69        0.0       587.38
   31     0.808      0.0     0.989     3481240.00     22.511      0.0         0.173     100.99        0.0       629.68
   32     0.904      0.0     0.989     3974230.00     11.255      0.0         0.173     103.02        0.0       718.85
   33     1.000      0.0     0.997     5129903.00      0.0        0.0         0.041     120.18        0.0       919.88
   40     0.800      0.0     0.0       1491527.00     23.390      0.0        15.320      43.68        0.0         0.0
   41     0.500      0.0     0.0        702287.50     58.475      0.0        15.320      32.90        0.0         0.0
   42     0.800      0.0     0.980      445813.88     23.390      0.0         0.306      13.05        0.0        81.35
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  4911      SITE=    30                 ORIGINAL EMISSIONS
                                                   SOX         CO          PART
                                                  39.020       0.0         4.980
                                             -----------------------------------

 DEVICE       EFFICIENCIES                 COST        CONTROLLED EMISSIONS            EFFECTIVENESS ($/TON)
           SOX        CO      PART        DOLLARS      SOX         CO          PART       SOX         CO          PART

   10     0.0        0.0     0.750      563794.75     39.020      0.0         1.245       0.0         0.0       413.56
   27     0.403      0.0     0.345      162704.00     23.299      0.0         3.262      28.35        0.0       259.44
   28     0.701      0.0     0.345      247745.00     11.649      0.0         3.262      24.80        0.0       395.04
   29     0.861      0.0     0.390      470610.00      5.423      0.0         3.037      38.38        0.0       663.54
   30     0.651      0.0     0.989     1005857.00     13.607      0.0         0.052     108.44        0.0       559.25
   31     0.826      0.0     0.989     1076533.00      6.803      0.0         0.052      91.55        0.0       598.54
   32     0.913      0.0     0.989     1225528.00      3.402      0.0         0.052      94.27        0.0       681.38
   33     1.000      0.0     0.997     1574804.00      0.0        0.0         0.013     110.57        0.0       868.55
   40     0.800      0.0     0.0        473623.00      7.804      0.0         4.980      41.57        0.0         0.0
   41     0.500      0.0     0.0        242326.06     19.510      0.0         4.980      34.03        0.0         0.0
   42     0.800      0.0     0.980      237211.94      7.804      0.0         0.100      20.82        0.0       133.16
```

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                         CONTROL COST-EFFECTIVENESS REPORT

       SIC=  4911     SITE=    40             ORIGINAL EMISSIONS
                                            SOX        CO         PART
                                          32.140      0.0        4.060

DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
          SOX      CO     PART       DOLLARS     SOX        CO        PART       SOX       CO        PART

  10     0.0      0.0    0.750      98839.19    32.140      0.0       1.015      0.0       0.0       98.93
  27     0.396    0.0    0.331     118256.00    19.397      0.0       2.716     25.43      0.0      240.99
  28     0.698    0.0    0.331     189056.00     9.699      0.0       2.716     23.08      0.0      385.28
  29     0.860    0.0    0.377     374600.00     4.515      0.0       2.528     37.15      0.0      670.05
  30     0.648    0.0    0.989     820556.00    11.328      0.0       0.044    108.02      0.0      559.73
  31     0.824    0.0    0.989     904878.56     5.664      0.0       0.044     93.64      0.0      617.24
  32     0.912    0.0    0.989    1003442.00     2.832      0.0       0.044     93.80      0.0      684.48
  33     1.000    0.0    0.997    1294228.00     0.0        0.0       0.010    110.32      0.0      875.60
  40     0.800    0.0    0.0       389803.06     6.428      0.0       4.060     41.54      0.0        0.0
  41     0.500    0.0    0.0       203475.25    16.070      0.0       4.060     34.69      0.0        0.0
  42     0.800    0.0    0.980     218021.56     6.428      0.0       0.081     23.23      0.0      150.13


                         CONTROL COST-EFFECTIVENESS REPORT

       SIC=  4911     SITE=    50             ORIGINAL EMISSIONS
                                            SOX        CO         PART
                                          192.080     0.0        1.970

DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
          SOX      CO     PART       DOLLARS     SOX        CO        PART       SOX       CO        PART

  10     0.0      0.0    0.750     418415.69   192.080      0.0       0.492      0.0       0.0      775.87
  27     0.402    0.0    0.592     813172.00   114.826      0.0       0.804     28.84      0.0     1910.35
  28     0.701    0.0    0.592    1232287.00    57.413      0.0       0.804     25.07      0.0     2894.96
  29     0.861    0.0    0.620    2330658.00    26.727      0.0       0.748     38.62      0.0     5226.87
  30     0.651    0.0    0.993    4955151.00    67.060      0.0       0.013    108.59      0.0     6936.66
  31     0.825    0.0    0.993    5303475.00    33.530      0.0       0.013     91.64      0.0     7424.27
  32     0.913    0.0    0.993    6037786.00    16.765      0.0       0.013     94.36      0.0     8452.23
  33     1.000    0.0    0.998    7759168.00     0.0        0.0       0.003    110.67      0.0    10807.79
  40     0.800    0.0    0.0      2337178.00    38.416      0.0       1.970     41.67      0.0        0.0
  41     0.500    0.0    0.0      1097690.00    96.040      0.0       1.970     31.31      0.0        0.0
  42     0.800    0.0    0.980     646532.56    38.416      0.0       0.039     11.53      0.0      917.50
```

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                        CONTROL COST-EFFECTIVENESS REPORT

        SIC=  4911       SITE=     60                ORIGINAL EMISSIONS
                                               SOX          CO          PART
                                              3.590        0.0         4.580
                                          -------------------------------

 DEVICE        EFFICIENCIES          COST         CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
          SOX        CO      PART    DOLLARS     SOX         CO          PART     SOX         CO          PART

   10     0.0        0.0     0.980   29153.14    3.590       0.0         0.092    0.0         0.0         17.80
   11     0.0        0.0     0.950   24916.51    3.590       0.0         0.229    0.0         0.0         15.69
   12     0.0        0.0     0.900   20902.22    3.590       0.0         0.458    0.0         0.0         13.89
   27     0.306      0.0     0.239   34007.00    2.490       0.0         3.486   84.71        0.0         85.18
   28     0.653      0.0     0.239   43096.00    1.245       0.0         3.486   50.35        0.0        107.94
   29     0.839      0.0     0.291   66915.44    0.580       0.0         3.246   60.90        0.0        137.40
   30     0.610      0.0     0.988  117881.56    1.400       0.0         0.054  147.49        0.0         71.36
   31     0.805      0.0     0.988  125154.63    0.700       0.0         0.054  118.65        0.0         75.76
   32     0.902      0.0     0.988  140487.06    0.350       0.0         0.054  119.80        0.0         85.04
   33     1.000      0.0     0.997  153743.69    0.0         0.0         0.012  117.33        0.0         92.21
```

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                        CONTROL COST-EFFECTIVENESS REPORT

        SIC=  4911       SITE=     70                ORIGINAL EMISSIONS
                                               SOX          CO          PART
                                             377.200       1.700       12.090
                                          -------------------------------

 DEVICE        EFFICIENCIES          COST         CONTROLLED EMISSIONS           EFFECTIVENESS ($/TON)
          SOX        CO      PART    DOLLARS      SOX         CO          PART     SOX         CO          PART

   10     0.0        0.0     0.750     780502.63  377.200     1.700       3.022     0.0         0.0        235.83
   27     0.379      0.139   0.322    1572169.00  234.300     1.464       8.201    30.14    18280.57     1107.43
   28     0.689      0.139   0.322    2427364.00  117.150     1.464       8.201    25.57    28224.45     1709.82
   29     0.855      0.198   0.368    4668569.00   54.536     1.363       7.635    39.64    37997.86     2871.05
   30     0.637      0.988   0.989   10016745.00  136.835     0.021       0.132   114.17    16345.44     2294.88
   31     0.819      0.988   0.989   10727497.00   68.418     0.021       0.132    95.18    17505.25     2457.72
   32     0.909      0.988   0.989   12225833.00   34.209     0.021       0.132    97.66    19950.25     2800.99
   33     1.000      1.000   0.997   15738281.00    0.0       0.0         0.031   114.31    25363.87     3575.77
   40     0.800      0.0     0.0      4673300.00   75.440     1.700      12.090    42.43        0.0          0.0
   41     0.500      0.0     0.0      2160890.00  188.600     1.700      12.090    31.39        0.0          0.0
   42     0.800      0.0     0.980    1140922.00   75.440     1.700       0.242    10.36        0.0        263.82
```

```
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  4953     SITE=  1301                  ORIGINAL EMISSIONS
                                                   SOX       CO        PART
                                                  0.300     0.150     2.550
                                              ---------------------------------

 DEVICE       EFFICIENCIES               COST      CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
           SOX       CO      PART       DOLLARS     SOX       CO        PART          SOX        CO        PART

    1      0.0       0.0     0.960     73375.81    0.300     0.150     0.102
    2      0.0       0.0     0.900     46241.59    0.300     0.150     0.255          0.0        0.0       82.12
    3      0.0       0.0     0.800     39364.37    0.300     0.150     0.255          0.0        0.0       55.20
   10      0.0       0.0     0.970     97289.38    0.300     0.150     0.510          0.0        0.0       52.87
   11      0.0       0.0     0.930     81707.56    0.300     0.150     0.076          0.0        0.0      107.76
   12      0.0       0.0     0.870     69604.88    0.300     0.150     0.179          0.0        0.0       94.39
                                                   0.300     0.150     0.331          0.0        0.0       85.96


                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  4953     SITE=  1311                  ORIGINAL EMISSIONS
                                                   SOX       CO        PART
                                                  0.300     0.150     2.550
                                              ---------------------------------

 DEVICE       EFFICIENCIES               COST      CONTROLLED EMISSIONS              EFFECTIVENESS ($/TON)
           SOX       CO      PART       DOLLARS     SOX       CO        PART          SOX        CO        PART

    1      0.0       0.0     0.960     73375.81    0.300     0.150     0.102
    2      0.0       0.0     0.900     46241.59    0.300     0.150     0.255          0.0        0.0       82.12
    3      0.0       0.0     0.800     39364.37    0.300     0.150     0.510          0.0        0.0       55.20
   10      0.0       0.0     0.970     97289.38    0.300     0.150     0.076          0.0        0.0       52.87
   11      0.0       0.0     0.930     81707.56    0.300     0.150     0.179          0.0        0.0      107.76
   12      0.0       0.0     0.870     69604.88    0.300     0.150     0.331          0.0        0.0       94.39
                                                                                      0.0        0.0       85.96
                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  9900      SITE=    200               ORIGINAL EMISSIONS
                                                   SOX      CO         PART
                                                  1.680     0.0        0.210
                                                ----------------------------

 DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
          SOX       CO      PART      DOLLARS     SOX       CO         PART     SOX       CO         PART

   10     0.0       0.0     0.900     23288.09    1.680     0.0        0.021    0.0       0.0       337.58
   11     0.0       0.0     0.800     18640.46    1.680     0.0        0.042    0.0       0.0       303.99
   12     0.0       0.0     0.500     14405.46    1.680     0.0        0.105    0.0       0.0       375.88
   27     0.306     0.0     0.368     24801.06    1.166     0.0        0.133  132.20       0.0       878.27
   28     0.653     0.0     0.368     35440.94    0.583     0.0        0.133   88.51       0.0      1255.05
   29     0.838     0.0     0.412     47419.94    0.271     0.0        0.123   92.23       0.0      1501.71
   30     0.610     0.0     0.978     55829.38    0.656     0.0        0.005  149.32       0.0       744.46
   31     0.805     0.0     0.978     60063.44    0.3[illegible]8     0.0        0.005  121.70       0.0       800.92
   32     0.902     0.0     0.978     68531.50    0.164     0.0        0.005  123.84       0.0       913.84
   33     1.000     0.0     0.997     81169.13    0.0       0.0        0.001  132.37       0.0      1062.32


                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  9900      SITE=    210               ORIGINAL EMISSIONS
                                                   SOX      CO         PART
                                                  3.290     0.0        2.940
                                                ----------------------------

 DEVICE      EFFICIENCIES              COST       CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
          SOX       CO      PART      DOLLARS     SOX       CO         PART     SOX       CO         PART

    7     0.0       0.0     0.800     10392.38    3.290     0.0        0.588    0.0       0.0        12.11
   10     0.0       0.0     0.980     29403.15    3.290     0.0        0.059    0.0       0.0        27.96
   11     0.0       0.0     0.950     23232.71    3.290     0.0        0.147    0.0       0.0        22.79
   12     0.0       0.0     0.900     17859.42    3.290     0.0        0.294    0.0       0.0        18.49
   27     0.306     0.0     0.381     48593.38    2.285     0.0        1.819  132.42       0.0       118.77
   28     0.653     0.0     0.381     69440.31    1.142     0.0        1.819   88.58       0.0       169.73
   29     0.838     0.0     0.424     92911.13    0.532     0.0        1.694   92.29       0.0       204.24
   30     0.610     0.0     0.979    107550.63    1.285     0.0        0.062  146.94       0.0       102.39
   31     0.805     0.0     0.979    115846.44    0.642     0.0        0.062  119.87       0.0       110.29
   32     0.902     0.0     0.979    132438.13    0.321     0.0        0.062  122.22       0.0       126.09
   33     1.000     0.0     0.997    157199.50    0.0       0.0        0.009  130.91       0.0       146.95
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                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  9900       SITE=   220              ORIGINAL EMISSIONS
                                                    SOX       CO         PART
                                                    2.200     0.0        2.840
                                                 ------------------------------

DEVICE       EFFICIENCIES               COST        CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
          SOX       CO      PART       DOLLARS      SOX       CO         PART         SOX        CO          PART

   7      0.0       0.0     0.850     16896.99      2.200     0.0        0.426        0.0        0.0         19.18
   8      0.0       0.0     0.700     15560.25      2.200     0.0        0.852        0.0        0.0         21.44
  10      0.0       0.0     0.980     31393.56      2.200     0.0        0.057        0.0        0.0         30.90
  11      0.0       0.0     0.950     26218.73      2.200     0.0        0.142        0.0        0.0         26.62
  12      0.0       0.0     0.900     21604.55      2.200     0.0        0.284        0.0        0.0         23.16
  27      0.299     0.0     0.383     32787.88      1.542     0.0        1.753      136.42       0.0         82.68
  28      0.650     0.0     0.383     46854.19      0.771     0.0        1.753       89.82       0.0        118.14
  29      0.837     0.0     0.425     62690.88      0.359     0.0        1.633       93.28       0.0        142.25
  30      0.606     0.0     0.979     73520.31      0.867     0.0        0.060      151.08       0.0         72.46
  31      0.803     0.0     0.979     79117.88      0.433     0.0        0.060      122.70       0.0         77.97
  32      0.901     0.0     0.979     90312.94      0.217     0.0        0.060      124.76       0.0         89.00
  33      1.000     0.0     0.997    107020.38      0.0       0.0        0.009      133.28       0.0        103.56


                              CONTROL COST-EFFECTIVENESS REPORT

          SIC=  9900       SITE=   230              ORIGINAL EMISSIONS
                                                    SOX       CO         PART
                                                    3.150     0.0        4.020
                                                 ------------------------------

DEVICE       EFFICIENCIES               COST        CONTROLLED EMISSIONS             EFFECTIVENESS ($/TON)
          SOX       CO      PART       DOLLARS      SOX       CO         PART         SOX        CO          PART

   7      0.0       0.0     0.850     12909.54      3.150     0.0        0.603        0.0        0.0         10.35
   8      0.0       0.0     0.700     11242.32      3.150     0.0        1.206        0.0        0.0         10.95
  10      0.0       0.0     0.980     34419.78      3.150     0.0        0.080        0.0        0.0         23.94
  11      0.0       0.0     0.950     28492.82      3.150     0.0        0.201        0.0        0.0         20.44
  12      0.0       0.0     0.900     23352.61      3.150     0.0        0.402        0.0        0.0         17.68
  27      0.307     0.0     0.383     46407.50      2.182     0.0        2.482      131.32       0.0         82.66
  28      0.654     0.0     0.383     66316.69      1.091     0.0        2.482       88.24       0.0        118.12
  29      0.839     0.0     0.425     88731.69      0.508     0.0        2.311       92.01       0.0        142.22
  30      0.611     0.0     0.979    101982.56      1.227     0.0        0.085      145.29       0.0         71.00
  31      0.805     0.0     0.979    109905.25      0.613     0.0        0.085      118.71       0.0         76.52
  32      0.903     0.0     0.979    125750.63      0.307     0.0        0.085      121.17       0.0         87.55
  33      1.000     0.0     0.997    149398.13      0.0       0.0        0.012      129.94       0.0        102.13
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                              CONTROL COST-EFFECTIVENESS REPORT

           SIC=  9900     SITE=   240                  ORIGINAL EMISSIONS
                                                    SOX       CO        PART
                                                   2.500     0.0        3.19
                                               ----------------------------

 DEVICE       EFFICIENCIES             COST        CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
           SOX       CO     PART      DOLLARS      SOX       CO         PART      SOX       CO        PART

    7      0.0      0.0     0.850    12715.56     2.500     0.0        0.479      0.0       0.0       12.85
    8      0.0      0.0     0.700    11042.30     2.500     0.0        0.957      0.0       0.0       13.55
   10      0.0      0.0     0.980    39806.92     2.500     0.0        0.064      0.0       0.0       34.89
   11      0.0      0.0     0.950    33925.27     2.500     0.0        0.160      0.0       0.0       30.67
   12      0.0      0.0     0.900    28815.31     2.500     0.0        0.319      0.0       0.0       27.50
   27      0.149    0.0     0.242    45230.50     2.126     0.0        2.419    331.77      0.0      160.70
   28      0.575    0.0     0.242    64634.75     1.063     0.0        2.419    123.25      0.0      229.64
   29      0.802    0.0     0.294    86481.25     0.495     0.0        2.252    118.17      0.0      252.61
   30      0.522    0.0     0.974    99522.81     1.196     0.0        0.083    209.06      0.0       87.75
   31      0.761    0.0     0.974   107244.56     0.598     0.0        0.083    154.47      0.0       94.56
   32      0.880    0.0     0.974   122688.06     0.299     0.0        0.083    152.71      0.0      108.18
   33      1.000    0.0     0.996   145735.81     0.0       0.0        0.012    159.71      0.0      125.64


                              CONTROL COST-EFFECTIVENESS REPORT

           SIC=  9900     SITE=   250                  ORIGINAL EMISSIONS
                                                    SOX       CO        PART
                                                   1.420     0.0        0.270
                                               ----------------------------

 DEVICE       EFFICIENCIES             COST        CONTROLLED EMISSIONS          EFFECTIVENESS ($/TON)
           SOX       CO     PART      DOLLARS      SOX       CO         PART      SOX       CO        PART

   10      0.0      0.0     0.900    37961.43     1.420     0.0        0.027      0.0       0.0      428.00
   11      0.0      0.0     0.800    32439.97     1.420     0.0        0.054      0.0       0.0      411.47
   12      0.0      0.0     0.500    27583.78     1.420     0.0        0.135      0.0       0.0      559.79
   27     -0.266    0.0     0.242    38252.56**   1.798     0.0        0.205      0.0       0.0     1601.76
   28      0.367    0.0     0.242    54663.25     0.899     0.0        0.205    287.57      0.0     2288.94
   29      0.705    0.0     0.295    73139.31     0.419     0.0        0.190    200.10      0.0     2519.35
   30      0.288    0.0     0.974    84940.38**   1.011     0.0        0.007    569.36      0.0      884.85
   31      0.644    0.0     0.974    91470.81     0.506     0.0        0.007    274.08      0.0      952.87
   32      0.822    0.0     0.974   104531.75     0.253     0.0        0.007    245.37      0.0     1088.93
```

Strategy 1 FUEL SUBSTITUTION STRATEGY SOURCE DATA

SOX REDUCTION 0.010 SULFUR CONTENT

REGIONAL COST = $10.536437 MILLIONS EFFECTIVENESS $12280.71 /TON

REGIONAL EMISSION = 838.15 TONS/DAY REGIONAL REDUCTION 42.98%

SIC CODE	SITE NO.	DEVICE ID	NEW EMISSION TONS/DAY	DEVICE COST	DEVICE EFFICIENCY	REDUCTION TONS/DAY
2010	900	28	0.978265E 00	$ 59469.	57.47 %	0.132173E 01
2010	910	28	0.216602E 01	$ 131672.	76.07 %	0.688398E 01
2010	920	28	0.210871E 01	$ 128188.	65.32 %	0.397129E 01
2020	2000	28	0.470357E 00	$ 28593.	65.16 %	0.879641E 00
2046	2200	28	0.476014E 01	$ 196672.	74.67 %	0.140298E 02
2082	800	28	0.545458E 00	$ 33158.	65.48 %	0.103454E 01
2082	810	28	0.535133E 01	$ 221098.	70.10 %	0.125486E 02
2082	820	28	0.812257E 00	$ 49377.	74.38 %	0.235774E 01
2800	400	28	0.433178E 01	$ -35604.	57.66 %	0.589822E 01
2800	410	28	0.799378E 01	$ 330275.	70.11 %	0.187462E 02
2800	420	28	0.913048E 00	$ 55504.	65.28 %	0.171695E 01
2800	430	28	0.233578E 01	$ 96506.	70.13 %	0.548422E 01
2819	330	28	0.863437E 01	$ 356741.	72.75 %	0.230556E 02
2819	340	28	0.626461E 01	$ 298129.	69.23 %	0.140954E 02
2822	1900	28	0.513837E 00	$ 31236.	75.76 %	0.160616E 01
2841	2300	28	0.824115E 00	$ 50098.	65.37 %	0.155588E 01
2911	630	34	0.0	$ 54400.	100.00 %	0.870000E 00
3200	1400	28	0.231594E 01	$ 131291.	66.68 %	0.463406E 01
3210	1210	34	0.0	$ 348783.	100.00 %	0.293000E 01
3312	1100	33	0.0	$ 68824.	100.00 %	0.153000E 01
3312	1110	34	0.0	$ 381058.	100.00 %	0.602000E 01
3323	700	33	0.0	$ 181111.	100.00 %	0.514000E 01
3323	710	34	0.0	$ 265165.	100.00 %	0.619000E 01
3711	2500	28	0.196444E 01	$ 119418.	65.29 %	0.369556E 01
3711	2510	28	0.164230E 01	$ 99836.	65.35 %	0.309770E 01
3742	2400	28	0.555339E 00	$ 33759.	65.29 %	0.104466E 01
4911	10	28	0.751383E 02	$ 1597353.	69.80 %	0.173662E 03
4911	20	28	0.385450E 02	$ 747448.	67.04 %	0.784050E 02
4911	30	28	0.116494E 02	$ 247745.	70.15 %	0.273706E 02
4911	40	28	0.969861E 01	$ 189056.	69.82 %	0.224414E 02
4911	50	28	0.574130E 02	$ 1232287.	70.11 %	0.134667E 03
4911	60	28	0.124506E 01	$ 43096.	65.32 %	0.234493E 01
4911	70	28	0.117150E 03	$ 2427364.	68.94 %	0.260049E 03
9900	200	28	0.583007E 00	$ 35441.	65.30 %	0.109699E 01
9900	210	28	0.114230E 01	$ 69440.	65.28 %	0.214770E 01
9900	220	28	0.770755E 00	$ 46854.	64.97 %	0.142924E 01
9900	230	28	0.109091E 01	$ 66317.	65.37 %	0.205908E 01
9900	240	28	0.106325E 01	$ 64635.	57.47 %	0.143675E 01
9900	250	28	0.899214E 00	$ 54663.	36.68 %	0.520785E 00

GROUND LEVEL CONCENTRATIONS

STRATEGY 1 REDUCTION TO POLLUTANT SOX   PPM

AIR QUALITY STANDARD 0.181082E-01

RECEPTOR	LOCATION		CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
	X	Y			
1	0.0	0.0	0.140185E-03	0.458512E-04	0.0
2	0.0	15.00	0.199744E-03	0.621132E-04	0.0
3	0.0	30.00	0.235938E-03	0.818208E-04	0.0
4	0.0	45.00	0.289451E-03	0.108313E-03	0.0
5	0.0	60.00	0.282745E-03	0.125117E-03	0.0
6	0.0	75.00	0.282525E-03	0.144197E-03	0.0
7	0.0	90.00	0.249162E-03	0.159645E-03	0.0
8	0.0	105.00	0.212034E-03	0.157126E-03	0.0
9	0.0	120.00	0.179911E-03	0.148311E-03	0.0
10	0.0	135.00	0.136836E-03	0.126601E-03	0.0
11	15.00	0.0	0.264287E-03	0.675195E-04	0.0
12	15.00	15.00	0.393194E-03	0.986231E-04	0.0
13	15.00	30.00	0.483000E-03	0.135205E-03	0.0
14	15.00	45.00	0.575563E-03	0.178869E-03	0.0
15	15.00	60.00	0.576840E-03	0.218977E-03	0.0
16	15.00	75.00	0.520410E-03	0.254172E-03	0.0
17	15.00	90.00	0.457697E-03	0.278599E-03	0.0
18	15.00	105.00	0.394352E-03	0.273253E-03	0.0
19	15.00	120.00	0.310929E-03	0.258121E-03	0.0
20	15.00	135.00	0.233623E-03	0.219076E-03	0.0
21	30.00	0.0	0.543033E-03	0.101056E-03	0.0
22	30.00	15.00	0.811530E-03	0.150566E-03	0.0
23	30.00	30.00	0.109482E-02	0.228917E-03	0.0
24	30.00	45.00	0.124171E-02	0.310939E-03	0.0
25	30.00	60.00	0.119072E-02	0.401667E-03	0.0
26	30.00	75.00	0.105568E-02	0.487522E-03	0.0
27	30.00	90.00	0.912846E-03	0.518569E-03	0.0
28	30.00	105.00	0.714153E-03	0.519617E-03	0.0
29	30.00	120.00	0.523562E-03	0.443796E-03	0.0
30	30.00	135.00	0.384180E-03	0.371791E-03	0.0
31	45.00	0.0	0.102713E-02	0.149692E-03	0.0
32	45.00	15.00	0.179507E-02	0.239230E-03	0.0
33	45.00	30.00	0.284559E-02	0.384842E-03	0.0
34	45.00	45.00	0.300413E-02	0.584918E-03	0.0
35	45.00	60.00	0.250226E-02	0.821083E-03	0.0
36	45.00	75.00	0.218907E-02	0.983381E-03	0.0
37	45.00	90.00	0.176992E-02	0.102987E-02	0.0
38	45.00	105.00	0.127508E-02	0.946315E-03	0.0
39	45.00	120.00	0.904734E-03	0.807481E-03	0.0
40	45.00	135.00	0.625172E-03	0.639413E-03	0.0

GROUND LEVEL CONCENTRATIONS

STRATEGY 1 REDUCTION TO POLLUTANT SOX PPM

AIR QUALITY STANDARD 0.181982E-01

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
41	60.00	0.0	0.171197E-02	0.200905E-03	0.0
42	60.00	15.00	0.515212E-02	0.406347E-03	0.0
43	60.00	30.00	0.120016E-01	0.760135E-03	0.0
44	60.00	45.00	0.757574E-02	0.130254E-02	0.0
45	60.00	60.00	0.572830E-02	0.230702E-02	0.0
46	60.00	75.00	0.529252E-02	0.240931E-02	0.0
47	60.00	90.00	0.365107E-02	0.197168E-02	0.0
48	60.00	105.00	0.221037E-02	0.153822E-02	0.0
49	60.00	120.00	0.150528E-02	0.145891E-02	0.0
50	60.00	135.00	0.971283E-03	0.108778E-02	0.0
51	75.00	0.0	0.278714E-02	0.290890E-03	0.0
52	75.00	15.00	0.122580E-01	0.857373E-03	0.0
53	75.00	30.00	0.409132E-01	0.123133E-02	0.228051E-01
54	75.00	45.00	0.126350E-01	0.259609E-02	0.0
55	75.00	60.00	0.181596E-01	0.841008E-02	0.514500E-04
56	75.00	75.00	0.176998E-01	0.812070E-02	0.0
57	75.00	90.00	0.713220E-02	0.393102E-02	0.0
58	75.00	105.00	0.349195E-02	0.232711E-02	0.0
59	75.00	120.00	0.234379E-02	0.255000E-02	0.0
60	75.00	135.00	0.136487E-02	0.165594E-02	0.0
61	90.00	0.0	0.296986E-02	0.343682E-03	0.0
62	90.00	15.00	0.753500E-02	0.662488E-03	0.0
63	90.00	30.00	0.785805E-02	0.129434E-02	0.0
64	90.00	45.00	0.937807E-02	0.376406E-02	0.0
65	90.00	60.00	0.329648E-01	0.200895E-01	0.148566E-01
66	90.00	75.00	0.310899E-01	0.396975E-01	0.129817E-01
67	90.00	90.00	0.106767E-01	0.800005E-02	0.0
68	90.00	105.00	0.513922E-02	0.374347E-02	0.0
69	90.00	120.00	0.253764E-02	0.262599E-02	0.0
70	90.00	135.00	0.136560E-02	0.158923E-02	0.0
71	105.00	0.0	0.208815E-02	0.431997E-03	0.0
72	105.00	15.00	0.326542E-02	0.785521E-03	0.0
73	105.00	30.00	0.379652E-02	0.140891E-02	0.0
74	105.00	45.00	0.606761E-02	0.320443E-02	0.0
75	105.00	60.00	0.108321E-01	0.705018E-02	0.0
76	105.00	75.00	0.934672E-02	0.578034E-02	0.0
77	105.00	90.00	0.602761E-02	0.424233E-02	0.0
78	105.00	105.00	0.310018E-02	0.219845E-02	0.0
79	105.00	120.00	0.168678E-02	0.158781E-02	0.0
80	105.00	135.00	0.103176E-02	0.115373E-02	0.0

GROUND LEVEL CONCENTRATIONS

STRATEGY 1 REDUCTION TO POLLUTANT SOX   PPM

AIR QUALITY STANDARD 0.181082E-01

RECEPTOR	LOCATION		CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
	X	Y			
81	120.00	0.0	0.132824E-02	0.444877E-03	0.0
82	120.00	15.00	0.184278E-02	0.754399E-03	0.0
83	120.00	30.00	0.236953E-02	0.126234E-02	0.0
84	120.00	45.00	0.336868E-02	0.208962E-02	0.0
85	120.00	60.00	0.400928E-02	0.274112E-02	0.0
86	120.00	75.00	0.352100E-02	0.276704E-02	0.0
87	120.00	90.00	0.273893E-02	0.234378E-02	0.0
88	120.00	105.00	0.169672E-02	0.144099E-02	0.0
89	120.00	120.00	0.106333E-02	0.105089E-02	0.0
90	120.00	135.00	0.646226E-03	0.710297E-03	0.0
91	135.00	0.0	0.874828E-03	0.409996E-03	0.0
92	135.00	15.00	0.115342E-02	0.633478E-03	0.0
93	135.00	30.00	0.145597E-02	0.937192E-03	0.0
94	135.00	45.00	0.182222E-02	0.126689E-02	0.0
95	135.00	60.00	0.189510E-02	0.147258E-02	0.0
96	135.00	75.00	0.172739E-02	0.154876E-02	0.0
97	135.00	90.00	0.142054E-02	0.134573E-02	0.0
98	135.00	105.00	0.974470E-03	0.911387E-03	0.0
99	135.00	120.00	0.653125E-03	0.659144E-03	0.0
100	135.00	135.00	0.440496E-03	0.479034E-03	0.0
101	150.00	0.0	0.580761E-03	0.344946E-03	0.0
102	150.00	15.00	0.734303E-03	0.482390E-03	0.0
103	150.00	30.00	0.861259E-03	0.635605E-03	0.0
104	150.00	45.00	0.991774E-03	0.768674E-03	0.0
105	150.00	60.00	0.959972E-03	0.834121E-03	0.0
106	150.00	75.00	0.880489E-03	0.816006E-03	0.0
107	150.00	90.00	0.703710E-03	0.665882E-03	0.0
108	150.00	105.00	0.537417E-03	0.523831E-03	0.0
109	150.00	120.00	0.389698E-03	0.396004E-03	0.0
110	150.00	135.00	0.278467E-03	0.302136E-03	0.0
111	165.00	0.0	0.393005E-03	0.269996E-03	0.0
112	165.00	15.00	0.468106E-03	0.352712E-03	0.0
113	165.00	30.00	0.519790E-03	0.421579E-03	0.0
114	165.00	45.00	0.561405E-03	0.474202E-03	0.0
115	165.00	60.00	0.523833E-03	0.478688E-03	0.0
116	165.00	75.00	0.471487E-03	0.450639E-03	0.0
117	165.00	90.00	0.387551E-03	0.371668E-03	0.0
118	165.00	105.00	0.307449E-03	0.302398E-03	0.0
119	165.00	120.00	0.238457E-03	0.248919E-03	0.0
120	165.00	135.00	0.174213E-03	0.192907E-03	0.0

GROUND LEVEL CONCENTRATIONS

STRATEGY 1 REDUCTION TO POLLUTANT SOX   PPM

AIR QUALITY STANDARD 0.181082E-01

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
121	74.55	68.50	0.209936E-01	0.881904E-02	0.288544E-02
122	79.55	69.90	0.361696E-01	0.186399E-01	0.180614E-01
123	82.05	53.40	0.235379E-01	0.119636E-01	0.542971E-02
124	82.55	79.30	0.216345E-01	0.144838E-01	0.352627E-02
125	83.05	69.50	0.544396E-01	0.278957E-01	0.363314E-01
126	83.55	58.00	0.349888E-01	0.199282E-01	0.168806E-01
127	89.25	63.50	0.793689E-01	0.343445E-01	0.612608E-01
128	91.85	72.50	0.327576E-01	0.363618E-01	0.146494E-01
129	98.45	68.00	0.275863E-01	0.118992E-01	0.947810E-02
130	94.55	68.00	0.293382E-01	0.194242E-01	0.112300E-01
131	101.25	94.00	0.674800E-02	0.402705E-02	0.0
132	105.05	64.60	0.114093E-01	0.646450E-02	0.0

```
                         STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT  SOX   PPM
ANNUAL

AVERAGING TIME   1. HRS.     STANDARD DEVIATION =  2.81

RECEPTOR |  ARITHMETIC  |  GEOMETRIC  |    MAXIMUM     |      0.1%      |      1.0%      |     10.0%      |
         |     MEAN     |    MEAN     | CONCENTRATION  | CONCENTRATION  | CONCENTRATION  | CONCENTRATION  |
---------------------------------------------------------------------------------------------------------------

   46      5.292524E-03   3.103658E-03   1.596013E-01    7.561034E-02    3.434747E-02    1.166758E-02
   56      1.769979E-02   1.037956E-02   5.337548E-01    2.528538E-01    1.148682E-01    3.901991E-02
   66      3.108992E-02   1.823185E-02   9.375477E-01    4.441586E-01    2.017676E-01    6.853896E-02
   76      9.346720E-03   5.481131E-03   2.818596E-01    1.335296E-01    6.065842E-02    2.060522E-02
   86      3.520998E-03   2.064795E-03   1.061792E-01    5.030189E-02    2.285060E-02    7.762183E-03
  121      2.099363E-02   1.231115E-02   6.330839E-01    2.999204E-01    1.362446E-01    4.628132E-02
  122      3.616958E-02   2.121069E-02   1.090730E 00    5.167281E-01    2.347337E-01    7.973731E-02
  123      2.353790E-02   1.380317E-02   7.098088E-01    3.362685E-01    1.527564E-01    5.189025E-02
  124      2.163446E-02   1.268695E-02   6.524088E-01    3.090755E-01    1.404034E-01    4.769405E-02
  125      5.443957E-02   3.192462E-02   1.641680E 00    7.777378E-01    3.533024E-01    1.200143E-01
  126      3.498878E-02   2.051823E-02   1.055121E 00    4.998588E-01    2.270705E-01    7.713419E-02
  127      7.936895E-02   4.654378E-02   2.393450E 00    1.133885E 00    5.150893E-01    1.749721E-01
```

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT SOX PPM
ANNUAL

AVERAGING TIME 8. HRS. STANDARD DEVIATION = 2.48

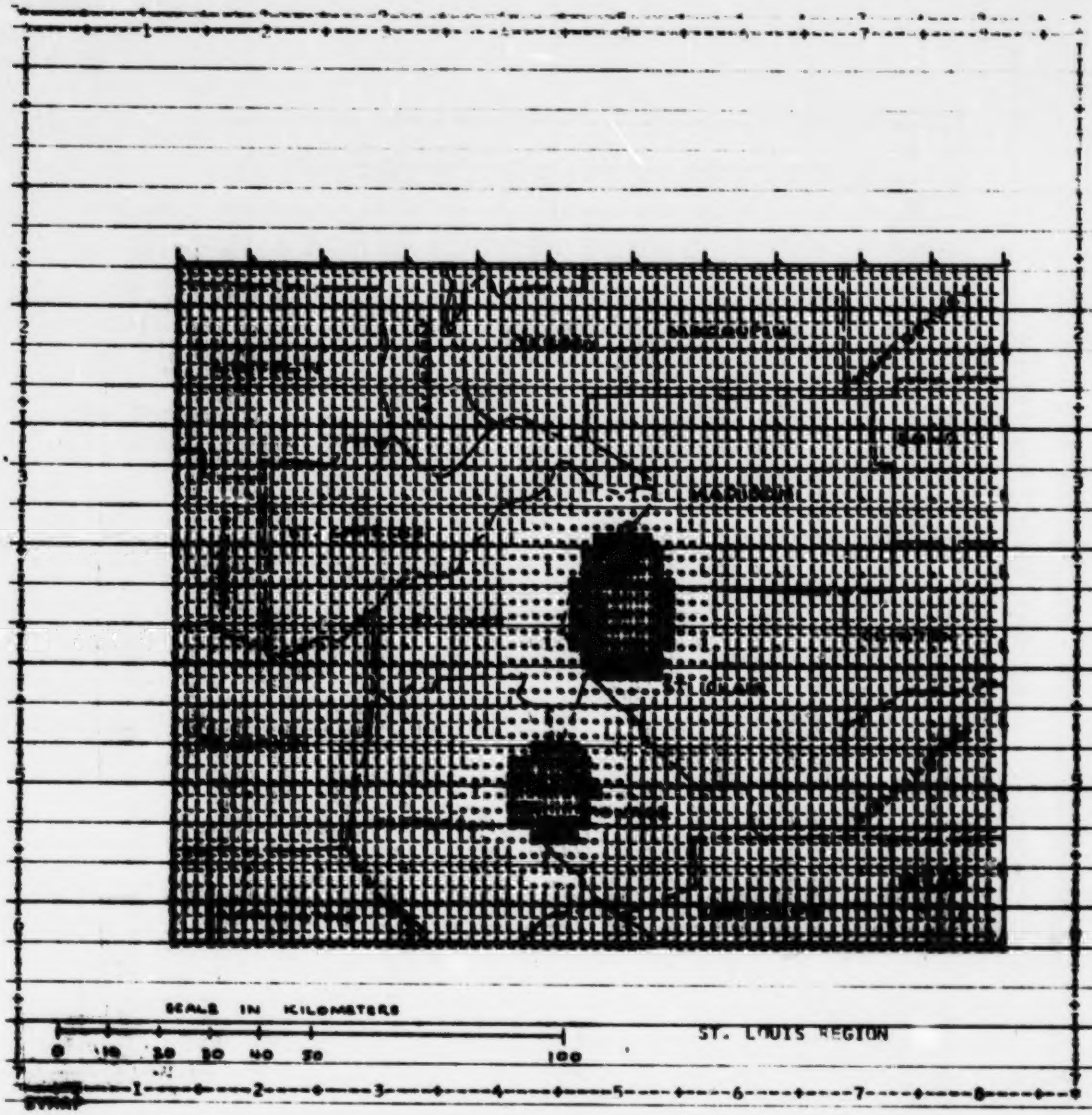
RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	5.292524E-03	3.507266E-03	6.780231E-02	5.788133E-02	2.895007E-02	1.121836E-02
56	1.769979E-02	1.172934E-02	2.267513E-01	1.935725E-01	9.681767E-02	3.751754E-02
66	3.108992E-02	2.060276E-02	3.982919E-01	3.400128E-01	1.700616E-01	6.590009E-02
76	9.346720E-03	6.193910E-03	1.197404E-01	1.022197E-01	5.112647E-02	1.981187E-02
86	3.520998E-03	2.333305E-03	4.510739E-02	3.850716E-02	1.925983E-02	7.463321E-03
121	2.099363E-02	1.391212E-02	2.689486E-01	2.295954E-01	1.148350E-01	4.449939E-02
122	3.616958E-02	2.396897E-02	4.633673E-01	3.955667E-01	1.978474E-01	7.665725E-02
123	2.353790E-02	1.559816E-02	3.015432E-01	2.574206E-01	1.287521E-01	4.989237E-02
124	2.163446E-02	1.433679E-02	2.771583E-01	2.366038E-01	1.183403E-01	4.585772E-02
125	5.443957E-02	3.607617E-02	6.974235E-01	5.953746E-01	2.977840E-01	1.153934E-01
126	3.498878E-02	2.318647E-02	4.482400E-01	3.826524E-01	1.913884E-01	7.416433E-02
127	7.936895E-02	5.259645E-02	1.016792E 00	8.680132E-01	4.341476E-01	1.682353E-01

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT SOX PPM
ANNUAL

AVERAGING TIME 24. HRS. STANDARD DEVIATION = 2.30

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	5.292524E-03	3.741275E-03	4.329412E-02	4.908482E-02	2.598255E-02	1.088068E-02
56	1.769979E-02	1.251195E-02	1.447885E-01	1.641544E-01	8.689344E-02	3.638824E-02
66	3.108992E-02	2.197741E-02	2.543230E-01	2.883394E-01	1.526295E-01	6.391644E-02
76	9.346720E-03	6.607179E-03	7.645839E-02	8.668488E-02	4.588579E-02	1.921552E-02
86	3.520998E-03	2.488987E-03	2.880261E-02	3.265503E-02	1.728561E-02	7.238671E-03
121	2.099363E-02	1.484036E-02	1.717329E-01	1.947026E-01	1.030639E-01	4.315992E-02
122	3.616958E-02	2.556821E-02	2.958759E-01	3.354501E-01	1.775671E-01	7.435948E-02
123	2.353790E-02	1.663890E-02	1.925457E-01	2.182992E-01	1.155545E-01	4.839058E-02
124	2.163446E-02	1.529336E-02	1.769751E-01	2.006460E-01	1.062099E-01	4.447738E-02
125	5.443957E-02	3.848323E-02	4.453288E-01	5.048926E-01	2.672598E-01	1.119200E-01
126	3.498878E-02	2.473350E-02	2.862166E-01	3.244988E-01	1.717702E-01	7.193196E-02
127	7.936899E-02	5.610576E-02	6.492571E-01	7.360970E-01	3.896455E-01	1.631712E-01


SCALE IN KILOMETERS
0 10 20 30 40 50 100
ST. LOUIS REGION
1
2
3
4
5
6
7
8

```
TIME =     0.0

C    SO2 CONCENTRATION IN PARTS PER MILLION FOR THE ANNUAL SEASON
C    WITH STRATEGY 1


DATA VALUE EXTREMES ARE           0.00          0.04


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
         ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
                                                    ABOVE
  MINIMUM       BELOW       0.01        0.02        0.03
  MAXIMUM        0.01       0.02        0.03


PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                            50.00       50.00


FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL             L           1           2           H
              ==========================================
              LLLLLLLLL   .........               HHHHHHHHHH
              LLLLLLLLL   .........               HHHHHHHHHH
  SYMBOLS     LLLLLLLLL   ....1....               HHHHHHHHHH
              LLLLLLLLL   .........               HHHHHHHHHH
              LLLLLLLLL   .........               HHHHHHHHHH
              ==========================================
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Strategy 3 SOURCE EMISSION STANDARD STRATEGY SOURCE DATA

PART REDUCTION

REGIONAL COST = $ 1.215575 MILLIONS EFFECTIVENESS $10531.29 /TON

REGIONAL EMISSION = 447.86 TONS/DAY REGIONAL REDUCTION 20.48%

SIC CODE	SITE NO.	DEVICE ID	NEW EMISSION TONS/DAY	DEVICE COST	DEVICE EFFICIENCY	REDUCTION TONS/DAY
2040	101	17	0.298003E-01	$ 36489.	99.00 %	0.295020E 01
2040	111	17	0.228002E-01	$ 32581.	99.00 %	0.225720E 01
2040	121	17	0.149002E-01	$ 16815.	99.00 %	0.147510E 01
2040	131	17	0.204002E-01	$ 31211.	99.00 %	0.201960E 01
2040	141	17	0.248003E-01	$ 33701.	99.00 %	0.245520E 01
2040	151	17	0.248003E-01	$ 33701.	99.00 %	0.245520E 01
2040	161	17	0.496005E-01	$ 47588.	99.00 %	0.491040E 01
2040	171	17	0.149002E-01	$ 14092.	99.00 %	0.147510E 01
2040	181	17	0.348004E-01	$ 39252.	99.00 %	0.344520E 01
2040	191	17	0.378004E-01	$ 40932.	99.00 %	0.374220E 01
2819	301	18	0.190000E 00	$ 32660.	90.00 %	0.171000E 01
2819	1601	1	0.438000E 00	$ 123058.	98.00 %	0.214620E 02
2819	2601	17	0.800009E-01	$ 69372.	99.00 %	0.792000E 01
2822	1901	8	0.507500E 00	$ 22043.	65.00 %	0.942500E 00
2851	1701	17	0.240003E-01	$ 19182.	99.00 %	0.237600E 01
2951	1501	7	0.756601E-01	$ 3551.	92.20 %	0.894340E 00
3210	1201	3	0.525000E 00	$ 29614.	85.00 %	0.297500E 01
3241	1001	10	0.418500E 00	$ 150870.	85.00 %	0.237150E 01
3250	2101	17	0.304003E-01	$ 44521.	99.00 %	0.300960E 01
3295	501	1	0.120000E 00	$ 16709.	90.00 %	0.108000E 01
3295	511	17	0.191802E 00	$ 43676.	99.00 %	0.189882E 02
3295	521	17	0.822009E-01	$ 24670.	99.00 %	0.813780E 01
3295	531	17	0.137001E 00	$ 33948.	99.00 %	0.135630E 02
3312	1112	12	0.370000E 00	$ 187663.	50.00 %	0.370000E 00
3323	701	2	0.110000E 00	$ 35696.	90.00 %	0.989999E 00
3323	711	3	0.150000E 00	$ 37410.	75.00 %	0.450000E 00
3323	721	16	0.101001E-01	$ 14586.	99.00 %	0.999898E 00

GROUND LEVEL CONCENTRATIONS

STRATEGY 3 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION		CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
	X	Y			
1	0.0	0.0	0.286485E-05	0.892314E-06	0.0
2	0.0	15.00	0.319199E-05	0.101580E-05	0.0
3	0.0	30.00	0.335633E-05	0.107441E-05	0.0
4	0.0	45.00	0.377647E-05	0.124343E-05	0.0
5	0.0	60.00	0.396472E-05	0.130780E-05	0.0
6	0.0	75.00	0.434592E-05	0.143348E-05	0.0
7	0.0	90.00	0.471286E-05	0.151270E-05	0.0
8	0.0	105.00	0.486116E-05	0.158705E-05	0.0
9	0.0	120.00	0.479932E-05	0.156294E-05	0.0
10	0.0	135.00	0.449182E-05	0.144284E-05	0.0
11	15.00	0.0	0.341321E-05	0.109300E-05	0.0
12	15.00	15.00	0.392489E-05	0.127445E-05	0.0
13	15.00	30.00	0.423292E-05	0.138604E-05	0.0
14	15.00	45.00	0.488531E-05	0.166724E-05	0.0
15	15.00	60.00	0.516016E-05	0.176721E-05	0.0
16	15.00	75.00	0.561752E-05	0.193214E-05	0.0
17	15.00	90.00	0.597096E-05	0.197831E-05	0.0
18	15.00	105.00	0.598958E-05	0.203639E-05	0.0
19	15.00	120.00	0.569125E-05	0.192816E-05	0.0
20	15.00	135.00	0.519433E-05	0.172206E-05	0.0
21	30.00	0.0	0.410744E-05	0.134272E-05	0.0
22	30.00	15.00	0.488058E-05	0.162809E-05	0.0
23	30.00	30.00	0.573136E-05	0.192917E-05	0.0
24	30.00	45.00	0.687700E-05	0.242177E-05	0.0
25	30.00	60.00	0.741595E-05	0.262490E-05	0.0
26	30.00	75.00	0.783849E-05	0.277408E-05	0.0
27	30.00	90.00	0.815427E-05	0.277633E-05	0.0
28	30.00	105.00	0.765964E-05	0.272628E-05	0.0
29	30.00	120.00	0.680754E-05	0.242093E-05	0.0
30	30.00	135.00	0.597441E-05	0.204039E-05	0.0
31	45.00	0.0	0.487350E-05	0.162203E-05	0.0
32	45.00	15.00	0.656654E-05	0.226590E-05	0.0
33	45.00	30.00	0.830809E-05	0.292366E-05	0.0
34	45.00	45.00	0.108076E-04	0.401268E-05	0.0
35	45.00	60.00	0.112669E-04	0.424825E-05	0.0
36	45.00	75.00	0.118524E-04	0.440427E-05	0.0
37	45.00	90.00	0.116106E-04	0.406994E-05	0.0
38	45.00	105.00	0.995187E-05	0.383535E-05	0.0
39	45.00	120.00	0.833199E-05	0.315888E-05	0.0
40	45.00	135.00	0.696594E-05	0.245682E-05	0.0

GROUND LEVEL CONCENTRATIONS

STRATEGY 3 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
41	60.00	0.0	0.553662E-05	0.189304E-05	0.0
42	60.00	15.00	0.920670E-05	0.330054E-05	0.0
43	60.00	30.00	0.166333E-04	0.622802E-05	0.0
44	60.00	45.00	0.203326E-04	0.794850E-05	0.0
45	60.00	60.00	0.216444E-04	0.138977E-04	0.0
46	60.00	75.00	0.212061E-04	0.811595E-05	0.0
47	60.00	90.00	0.178747E-04	0.681661E-05	0.0
48	60.00	105.00	0.132367E-04	0.606976E-05	0.0
49	60.00	120.00	0.101572E-04	0.418464E-05	0.0
50	60.00	135.00	0.803036E-05	0.291416E-05	0.0
51	75.00	0.0	0.687202E-05	0.235617E-05	0.0
52	75.00	15.00	0.129126E-04	0.470404E-05	0.0
53	75.00	30.00	0.899960E-04	0.364031E-04	0.0
54	75.00	45.00	0.305530E-04	0.124857E-04	0.0
55	75.00	60.00	0.459267E-04	0.388956E-04	0.0
56	75.00	75.00	0.524776E-04	0.163435E-04	0.0
57	75.00	90.00	0.274255E-04	0.165172E-04	0.0
58	75.00	105.00	0.168327E-04	0.103303E-04	0.0
59	75.00	120.00	0.124390E-04	0.538837E-05	0.0
60	75.00	135.00	0.971943E-05	0.354429E-05	0.0
61	90.00	0.0	0.735884E-05	0.252373E-05	0.0
62	90.00	15.00	0.119602E-04	0.427127E-05	0.0
63	90.00	30.00	0.178167E-04	0.636493E-05	0.0
64	90.00	45.00	0.278426E-04	0.911443E-05	0.0
65	90.00	60.00	0.832867E-04	0.224919E-04	0.0
66	90.00	75.00	0.125736E-03	0.418849E-04	0.0
67	90.00	90.00	0.359726E-04	0.279932E-04	0.0
68	90.00	105.00	0.204937E-04	0.110510E-04	0.0
69	90.00	120.00	0.143222E-04	0.553435E-05	0.0
70	90.00	135.00	0.106031E-04	0.357087E-05	0.0
71	105.00	0.0	0.725892E-05	0.238352E-05	0.0
72	105.00	15.00	0.102817E-04	0.341283E-05	0.0
73	105.00	30.00	0.139864E-04	0.441376E-05	0.0
74	105.00	45.00	0.225402E-04	0.647298E-05	0.0
75	105.00	60.00	0.398541E-04	0.102738E-04	0.0
76	105.00	75.00	0.315954E-04	0.116580E-04	0.0
77	105.00	90.00	0.219048E-04	0.836506E-05	0.0
78	105.00	105.00	0.140183E-04	0.567934E-05	0.0
79	105.00	120.00	0.107200E-04	0.380680E-05	0.0
80	105.00	135.00	0.887851E-05	0.272636E-05	0.0

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                                   GROUND LEVEL CONCENTRATIONS

    STRATEGY 3 REDUCTION TO POLLUTANT PART  G/CU M.

    AIR QUALITY STANDARD  0.216967E-03

  | RECEPTOR |          LOCATION          | CONCENTRATION |    AMOUNT     |  AMOUNT IN  |
  |          |      X       |      Y      |     VALUE     |    REDUCED    |   EXCESS    |
  |    81    |    120.00    |       0.0   | 0.682540E-05  | 0.214416E-05  |  0.0        |
  |    82    |    120.00    |      15.00  | 0.896303E-05  | 0.277370E-05  |  0.0        |
  |    83    |    120.00    |      30.00  | 0.117478E-04  | 0.349379E-05  |  0.0        |
  |    84    |    120.00    |      45.00  | 0.161666E-04  | 0.461052E-05  |  0.0        |
  |    85    |    120.00    |      60.00  | 0.185607E-04  | 0.542664E-05  |  0.0        |
  |    86    |    120.00    |      75.00  | 0.172060E-04  | 0.526014E-05  |  0.0        |
  |    87    |    120.00    |      90.00  | 0.147261E-04  | 0.439136E-05  |  0.0        |
  |    88    |    120.00    |     105.00  | 0.106389E-04  | 0.346648E-05  |  0.0        |
  |    89    |    120.00    |     120.00  | 0.864505E-05  | 0.277164E-05  |  0.0        |
  |    90    |    120.00    |     135.00  | 0.692735E-05  | 0.212629E-05  |  0.0        |
  |    91    |    135.00    |       0.0   | 0.630086E-05  | 0.190060E-05  |  0.0        |
  |    92    |    135.00    |      15.00  | 0.779752E-05  | 0.233588E-05  |  0.0        |
  |    93    |    135.00    |      30.00  | 0.954115E-05  | 0.272665E-05  |  0.0        |
  |    94    |    135.00    |      45.00  | 0.115077E-04  | 0.324105E-05  |  0.0        |
  |    95    |    135.00    |      60.00  | 0.119743E-04  | 0.340591E-05  |  0.0        |
  |    96    |    135.00    |      75.00  | 0.118776E-04  | 0.325140E-05  |  0.0        |
  |    97    |    135.00    |      90.00  | 0.106282E-04  | 0.277394E-05  |  0.0        |
  |    98    |    135.00    |     105.00  | 0.833673E-05  | 0.246309E-05  |  0.0        |
  |    99    |    135.00    |     120.00  | 0.685576E-05  | 0.205573E-05  |  0.0        |
  |   100    |    135.00    |     135.00  | 0.588583E-05  | 0.173907E-05  |  0.0        |
  |   101    |    150.00    |       0.0   | 0.577704E-05  | 0.168886E-05  |  0.0        |
  |   102    |    150.00    |      15.00  | 0.676204E-05  | 0.193614E-05  |  0.0        |
  |   103    |    150.00    |      30.00  | 0.772644E-05  | 0.215939E-05  |  0.0        |
  |   104    |    150.00    |      45.00  | 0.853808E-05  | 0.239876E-05  |  0.0        |
  |   105    |    150.00    |      60.00  | 0.853907E-05  | 0.236346E-05  |  0.0        |
  |   106    |    150.00    |      75.00  | 0.823963E-05  | 0.225227E-05  |  0.0        |
  |   107    |    150.00    |      90.00  | 0.720712E-05  | 0.197564E-05  |  0.0        |
  |   108    |    150.00    |     105.00  | 0.629543E-05  | 0.183621E-05  |  0.0        |
  |   109    |    150.00    |     120.00  | 0.546455E-05  | 0.158006E-05  |  0.0        |
  |   110    |    150.00    |     135.00  | 0.483354E-05  | 0.140273E-05  |  0.0        |
  |   111    |    165.00    |       0.0   | 0.516450E-05  | 0.145480E-05  |  0.0        |
  |   112    |    165.00    |      15.00  | 0.587013E-05  | 0.163814E-05  |  0.0        |
  |   113    |    165.00    |      30.00  | 0.635176E-05  | 0.176345E-05  |  0.0        |
  |   114    |    165.00    |      45.00  | 0.667624E-05  | 0.185633E-05  |  0.0        |
  |   115    |    165.00    |      60.00  | 0.645967E-05  | 0.178241E-05  |  0.0        |
  |   116    |    165.00    |      75.00  | 0.609286E-05  | 0.167331E-05  |  0.0        |
  |   117    |    165.00    |      90.00  | 0.549567E-05  | 0.152371E-05  |  0.0        |
  |   118    |    165.00    |     105.00  | 0.497384E-05  | 0.142043E-05  |  0.0        |
  |   119    |    165.00    |     120.00  | 0.452548E-05  | 0.129579E-05  |  0.0        |
  |   120    |    165.00    |     135.00  | 0.406243E-05  | 0.115955E-05  |  0.0        |
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GROUND LEVEL CONCENTRATIONS

STRATEGY 3 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
121	74.55	68.50	0.569377E-04	0.169577E-04	0.0
122	79.55	69.90	0.990030E-04	0.247676E-04	0.0
123	82.05	53.40	0.569158E-04	0.186434E-04	0.0
124	82.55	79.30	0.672748E-04	0.207617E-04	0.0
125	83.05	69.50	0.138271E-03	0.274524E-04	0.0
126	83.55	58.00	0.815453E-04	0.179481E-04	0.0
127	89.25	63.50	0.152780E-03	0.318877E-04	0.0
128	91.85	72.50	0.118675E-03	0.400703E-04	0.0
129	98.45	68.00	0.572508E-04	0.219550E-04	0.0
130	94.55	68.00	0.870478E-04	0.300984E-04	0.0
131	101.25	94.00	0.218105E-04	0.939756E-05	0.0
132	105.05	64.60	0.367400E-04	0.112318E-04	0.0

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT PART G/CU M.
ANNUAL

AVERAGING TIME 1. HRS. HAS STANDARD DEVIATION = 2.10

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	2.120611E-05	1.609330E-05	2.734759E-04	1.598255E-04	9.062850E-05	4.169943E-05
56	5.147757E-05	3.906629E-05	6.638598E-04	3.879745E-04	2.199996E-04	1.012249E-04
66	1.257358E-04	9.542084E-05	1.621502E-03	9.476421E-04	5.373571E-04	2.472454E-04
76	3.159538E-05	2.397771E-05	4.074571E-04	2.381272E-04	1.350291E-04	6.212878E-05
86	1.720604E-05	1.305765E-05	2.218908E-04	1.296780E-04	7.353343E-05	3.383376E-05
121	5.693769E-05	4.320996E-05	7.342738E-04	4.291262E-04	2.433345E-04	1.119616E-04
122	9.900298E-05	7.513330E-05	1.276752E-03	7.461628E-04	4.231089E-04	1.946783E-04
123	5.691579E-05	4.319334E-05	7.339914E-04	4.289611E-04	2.432409E-04	1.119185E-04
124	6.727481E-05	5.105480E-05	8.675824E-04	5.070346E-04	2.875121E-04	1.322884E-04
125	1.382713E-04	1.049340E-04	1.783161E-03	1.042119E-03	5.909300E-04	2.718950E-04
126	8.154529E-05	6.188467E-05	1.051616E-03	6.145881E-04	3.485000E-04	1.603497E-04
127	1.527804E-04	1.159450E-04	1.970272E-03	1.151471E-03	6.529375E-04	3.004256E-04

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                              STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT   PART G/CU M.
ANNUAL


AVERAGING TIME    8. HRS.  HAS STANDARD DEVIATION =  1.92

RECEPTOR | ARITHMETIC  |  GEOMETRIC  |    MAXIMUM    |      0.1%      |      1.0%      |      10.0%     |
         |    MEAN     |    MEAN     | CONCENTRATION | CONCENTRATION  | CONCENTRATION  | CONCENTRATION  |
---------------------------------------------------------------------------------------------------------

   46      2.120611E-05  1.714316E-05   1.441731E-04    1.286727E-04     7.819090E-05     3.954965E-05

   56      5.147757E-05  4.161480E-05   3.499782E-04    3.123512E-04     1.898074E-04     9.600625E-05

   66      1.257358E-04  1.016457E-04   8.548347E-04    7.629292E-04     4.636114E-04     2.344988E-04

   76      3.159538E-05  2.554190E-05   2.148061E-04    1.917117E-04     1.164980E-04     5.892573E-05

   86      1.720604E-05  1.390947E-05   1.169780E-04    1.044014E-04     6.344188E-05     3.208946E-05

  121      5.693769E-05  4.602878E-05   3.870996E-04    3.454816E-04     2.099399E-04     1.061894E-04

  122      9.900298E-05  8.003466E-05   6.730873E-04    6.007219E-04     3.650424E-04     1.846417E-04

  123      5.691579E-05  4.601108E-05   3.869508E-04    3.453486E-04     2.098591E-04     1.061486E-04

  124      6.727481E-05  5.438538E-05   4.573783E-04    4.082043E-04     2.480547E-04     1.254683E-04

  125      1.382713E-04  1.117794E-04   9.400593E-04    8.389910E-04     5.098321E-04     2.578774E-04

  126      8.154529E-05  6.592175E-05   5.543984E-04    4.947938E-04     3.006726E-04     1.520829E-04

  127      1.527804E-04  1.235087E-04   1.038702E-03    9.270282E-04     5.633300E-04     2.849372E-04
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                              STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT  PART G/CU M.
ANNUAL


AVERAGING TIME  24. HRS. HAS STANDARD DEVIATION =  1.82

RECEPTOR |  ARITHMETIC  |  GEOMETRIC  |    MAXIMUM     |      0.1%      |      1.0%      |      10.0%     |
         |     MEAN     |    MEAN     | CONCENTRATION  | CONCENTRATION  | CONCENTRATION  | CONCENTRATION  |
---------------------------------------------------------------------------------------------------------

   46      2.120611E-05   1.772519E-05   1.030742E-04     1.128097E-04     7.140364E-05     3.818840E-05
   56      5.147757E-05   4.302769E-05   2.502112E-04     2.738440E-04     1.733315E-04     9.270187E-05
   66      1.257358E-04   1.050967E-04   6.111497E-04     6.688740E-04     4.233681E-04     2.264276E-04
   76      3.159538E-05   2.640929E-05   1.535721E-04     1.680773E-04     1.063856E-04     5.689760E-05
   86      1.720604E-05   1.438172E-05   8.363146E-05     9.153062E-05     5.793490E-05     3.098499E-05
  121      5.693769E-05   4.759153E-05   2.767504E-04     3.028901E-04     1.917163E-04     1.025345E-04
  122      9.900298E-05   8.275194E-05   4.812125E-04     5.266641E-04     3.333553E-04     1.782866E-04
  123      5.691579E-05   4.757322E-05   2.766440E-04     3.027737E-04     1.916426E-04     1.024951E-04
  124      6.727481E-05   5.623185E-05   3.269950E-04     3.578903E-04     2.265227E-04     1.211498E-04
  125      1.382713E-04   1.155745E-04   6.720799E-04     7.355590E-04     4.655768E-04     2.490017E-04
  126      8.154529E-05   6.815998E-05   3.963578E-04     4.337947E-04     2.745732E-04     1.468484E-04
  127      1.527804E-04   1.277020E-04   7.426024E-04     8.127426E-04     5.144307E-04     2.751299E-04
```

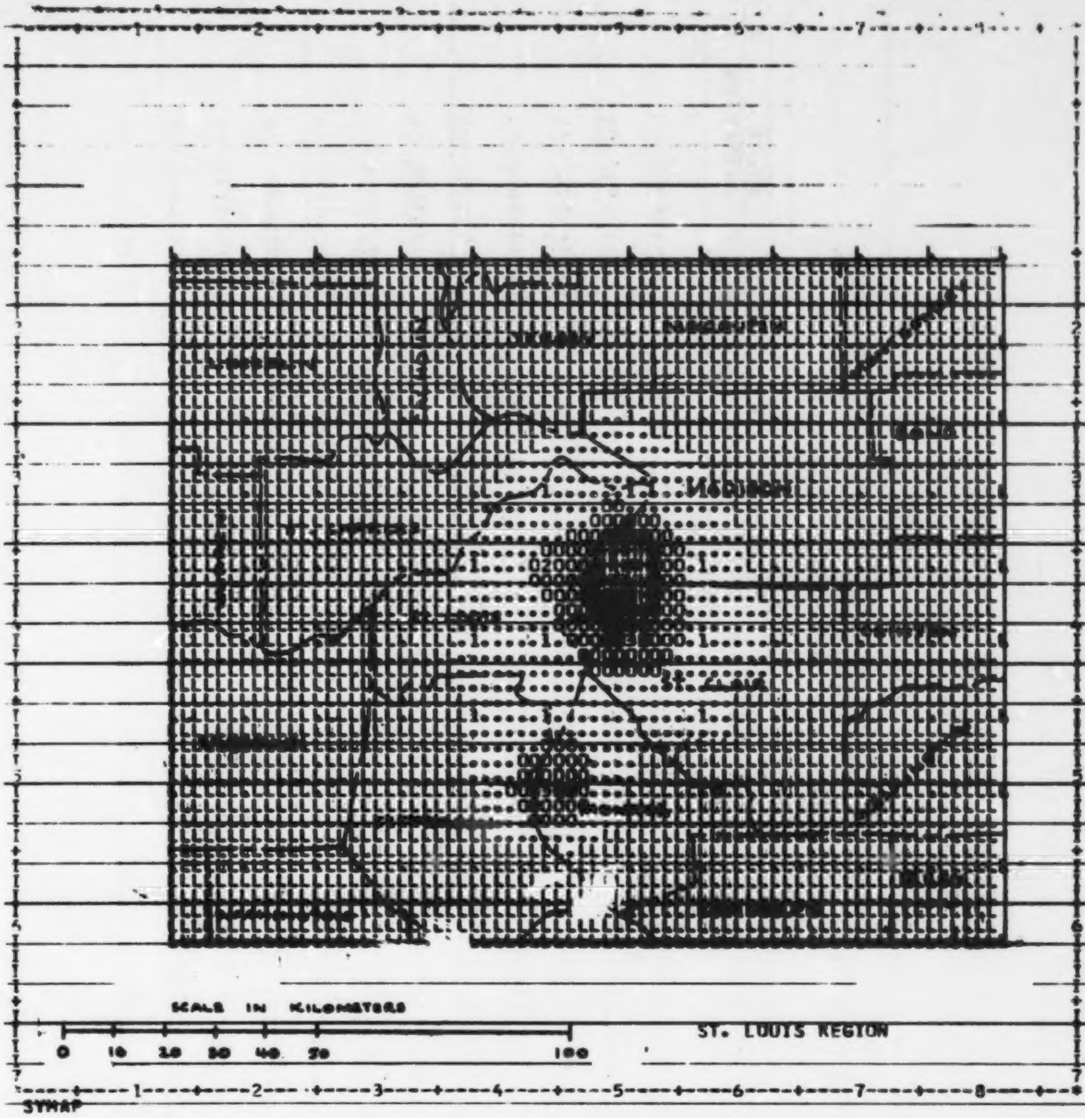

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SYMAP

TIME =     0.0

C   PARTICULATE CONCENTRATION IN MICROGRAMS PER CUBIC METER
C   FOR THE ANNUAL SEASON USING STRATEGY 3



DATA VALUE EXTREMES ARE          2.86       125.74


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
                                                          ABOVE
  MINIMUM       BELOW       20.00       50.00       80.00     110.00
  MAXIMUM       20.00       50.00       80.00      110.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                            33.33       33.33       33.33

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL            L           1           2           3           H                 B-94
              ====================================================================
              LLLLLLLLL  .........  000000000  █████████  HHHHHHHHH
              LLLLLLLLL  .........  000000000  █████████  HHHHHHHHH
   SYMBOLS    LLLLLLLLL  ....1....  000020000  ████3████  HHHHHHHHH
              LLLLLLLLL  .........  000000000  █████████  HHHHHHHHH
              LLLLLLLLL  .........  000000000  █████████  HHHHHHHHH
              ====================================================================
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B-83

Strategy 4 SOURCE EMISSION STANDARD STRATEGY SOURCE DATA

PART REDUCTION

REGIONAL COST = $ 2.060574 MILLIONS EFFECTIVENESS $ 9670.57 /TON

REGIONAL EMISSION = 350.15 TONS/DAY REGIONAL REDUCTION 37.83%

SIC CODE	SITE NO.	DEVICE ID	NEW EMISSION TONS/DAY	DEVICE COST	DEVICE EFFICIENCY	REDUCTION TONS/DAY
2010	900	12	0.246000E 00	$ 34885.	88.00 %	0.180400E 01
2010	910	11	0.578000E 00	$ 41577.	95.00 %	0.109820E 02
2010	920	12	0.652800E 00	$ 30387.	88.00 %	0.478720E 01
2020	2000	11	0.865000E-01	$ 18616.	95.00 %	0.164350E 01
2046	2200	30	0.192467E 00	$ 373182.	98.22 %	0.106075E 02
2082	800	11	0.100500E 00	$ 23239.	95.00 %	0.190950E 01
2082	810	12	0.458000E 00	$ 60969.	80.00 %	0.183200E 01
2082	820	11	0.200000E 00	$ 24419.	95.00 %	0.380000E 01
2800	400	27	0.137967E 01	$ -114659.	30.32 %	0.600326E 00
2800	410	12	0.102400E 01	$ 67247.	80.00 %	0.409600E 01
2800	420	12	0.283200E 00	$ 20968.	88.00 %	0.207680E 01
2800	430	12	0.718800E 00	$ 51208.	88.00 %	0.527120E 01
2819	330	12	0.192600E 01	$ 152706.	90.00 %	0.173340E 02
2819	340	12	0.780000E 00	$ 102008.	80.00 %	0.312000E 01
2822	1900	10	0.852001E-01	$ 27056.	98.00 %	0.417480E 01
2841	2300	12	0.114000E 00	$ 20441.	85.00 %	0.646000E 00
3200	1400	30	0.180315E 00	$ 201392.	97.93 %	0.851968E 01
3323	700	7	0.103500E 01	$ 13689.	85.00 %	0.586500E 01
3711	2500	7	0.432000E 00	$ 29945.	60.00 %	0.648000E 00
3711	2510	11	0.302500E 00	$ 31218.	95.00 %	0.574750E 01
3742	2400	12	0.146400E 00	$ 18383.	88.00 %	0.107360E 01
4911	10	11	0.168150E 02	$ 429464.	85.00 %	0.952850E 02
4911	30	27	0.326182E 01	$ 162704.	34.50 %	0.171817E 01
4911	40	10	0.101500E 01	$ 98839.	75.00 %	0.304500E 01
4911	60	11	0.229000E 00	$ 24917.	95.00 %	0.435100E 01
9900	200	12	0.105000E 00	$ 14405.	50.00 %	0.105000E 00
9900	210	12	0.294000E 00	$ 17859.	90.00 %	0.264600E 01
9900	220	11	0.142000E 00	$ 26219.	95.00 %	0.269800E 01
9900	230	11	0.201000E 00	$ 28493.	95.00 %	0.381900E 01
9900	240	12	0.319000E 00	$ 28815.	90.00 %	0.287100E 01

GROUND LEVEL CONCENTRATIONS

STRATEGY 4 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
1	0.0	0.0	0.253955E-05	0.121761E-05	0.0
2	0.0	15.00	0.288168E-05	0.132611E-05	0.0
3	0.0	30.00	0.303654E-05	0.139421E-05	0.0
4	0.0	45.00	0.353031E-05	0.148959E-05	0.0
5	0.0	60.00	0.375849E-05	0.151404E-05	0.0
6	0.0	75.00	0.406105E-05	0.171834E-05	0.0
7	0.0	90.00	0.429078E-05	0.193477E-05	0.0
8	0.0	105.00	0.438366E-05	0.206455E-05	0.0
9	0.0	120.00	0.423201E-05	0.213025E-05	0.0
10	0.0	135.00	0.387338E-05	0.206128E-05	0.0
11	15.00	0.0	0.313501E-05	0.137119E-05	0.0
12	15.00	15.00	0.363220E-05	0.156714E-05	0.0
13	15.00	30.00	0.393671E-05	0.168225E-05	0.0
14	15.00	45.00	0.472772E-05	0.182483E-05	0.0
15	15.00	60.00	0.503945E-05	0.188791E-05	0.0
16	15.00	75.00	0.536145E-05	0.218821E-05	0.0
17	15.00	90.00	0.550616E-05	0.244312E-05	0.0
18	15.00	105.00	0.549642E-05	0.252954E-05	0.0
19	15.00	120.00	0.511726E-05	0.250214E-05	0.0
20	15.00	135.00	0.456998E-05	0.234640E-05	0.0
21	30.00	0.0	0.390165E-05	0.154851E-05	0.0
22	30.00	15.00	0.468778E-05	0.182089E-05	0.0
23	30.00	30.00	0.551173E-05	0.214880E-05	0.0
24	30.00	45.00	0.693863E-05	0.236014E-05	0.0
25	30.00	60.00	0.743660E-05	0.260425E-05	0.0
26	30.00	75.00	0.756044E-05	0.305213E-05	0.0
27	30.00	90.00	0.760741E-05	0.332319E-05	0.0
28	30.00	105.00	0.710921E-05	0.327673E-05	0.0
29	30.00	120.00	0.624159E-05	0.298688E-05	0.0
30	30.00	135.00	0.529907E-05	0.271573E-05	0.0
31	45.00	0.0	0.478131E-05	0.171421E-05	0.0
32	45.00	15.00	0.668008E-05	0.215237E-05	0.0
33	45.00	30.00	0.847364E-05	0.275811E-05	0.0
34	45.00	45.00	0.113888E-04	0.343149E-05	0.0
35	45.00	60.00	0.114105E-04	0.410457E-05	0.0
36	45.00	75.00	0.115701E-04	0.468658E-05	0.0
37	45.00	90.00	0.108797E-04	0.480082E-05	0.0
38	45.00	105.00	0.953501E-05	0.425221E-05	0.0
39	45.00	120.00	0.781015E-05	0.368073E-05	0.0
40	45.00	135.00	0.626737E-05	0.315540E-05	0.0

GROUND LEVEL CONCENTRATIONS

STRATEGY 4 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
41	60.00	0.0	0.560199E-05	0.182767E-05	0.0
42	60.00	15.00	0.100635E-04	0.244370E-05	0.0
43	60.00	30.00	0.192645E-04	0.359632E-05	0.0
44	60.00	45.00	0.224201E-04	0.586075E-05	0.0
45	60.00	60.00	0.258968E-04	0.964511E-05	0.0
46	60.00	75.00	0.207708E-04	0.855131E-05	0.0
47	60.00	90.00	0.174173E-04	0.727405E-05	0.0
48	60.00	105.00	0.137724E-04	0.553411E-05	0.0
49	60.00	120.00	0.993285E-05	0.440904E-05	0.0
50	60.00	135.00	0.733020E-05	0.361433E-05	0.0
51	75.00	0.0	0.704202E-05	0.218616E-05	0.0
52	75.00	15.00	0.146770E-04	0.293971E-05	0.0
53	75.00	30.00	0.121994E-03	0.440503E-05	0.0
54	75.00	45.00	0.339902E-04	0.904836E-05	0.0
55	75.00	60.00	0.637837E-04	0.210388E-04	0.0
56	75.00	75.00	0.470144E-04	0.208068E-04	0.0
57	75.00	90.00	0.328137E-04	0.111288E-04	0.0
58	75.00	105.00	0.203839E-04	0.677902E-05	0.0
59	75.00	120.00	0.123481E-04	0.547925E-05	0.0
60	75.00	135.00	0.868952E-05	0.457420E-05	0.0
61	90.00	0.0	0.753035E-05	0.235222E-05	0.0
62	90.00	15.00	0.129412E-04	0.329027E-05	0.0
63	90.00	30.00	0.188869E-04	0.529468E-05	0.0
64	90.00	45.00	0.256777E-04	0.112792E-04	0.0
65	90.00	60.00	0.601664E-04	0.456123E-04	0.0
66	90.00	75.00	0.935618E-04	0.740590E-04	0.0
67	90.00	90.00	0.490236E-04	0.149423E-04	0.0
68	90.00	105.00	0.234854E-04	0.805885E-05	0.0
69	90.00	120.00	0.129953E-04	0.686124E-05	0.0
70	90.00	135.00	0.885284E-05	0.532114E-05	0.0
71	105.00	0.0	0.705185E-05	0.259059E-05	0.0
72	105.00	15.00	0.101225E-04	0.357200E-05	0.0
73	105.00	30.00	0.128511E-04	0.554903E-05	0.0
74	105.00	45.00	0.186745E-04	0.103390E-04	0.0
75	105.00	60.00	0.287120E-04	0.214160E-04	0.0
76	105.00	75.00	0.289176E-04	0.143358E-04	0.0
77	105.00	90.00	0.209953E-04	0.927455E-05	0.0
78	105.00	105.00	0.139438E-04	0.575388E-05	0.0
79	105.00	120.00	0.955630E-05	0.497052E-05	0.0
80	105.00	135.00	0.719913E-05	0.440574E-05	0.0

GROUND LEVEL CONCENTRATIONS

STRATEGY 4 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION		CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
	X	Y			
81	120.00	0.0	0.634421E-05	0.262536E-05	0.0
82	120.00	15.00	0.817533E-05	0.356140E-05	0.0
83	120.00	30.00	0.101653E-04	0.507635E-05	0.0
84	120.00	45.00	0.132770E-04	0.750017E-05	0.0
85	120.00	60.00	0.151481E-04	0.883957E-05	0.0
86	120.00	75.00	0.140401E-04	0.842630E-05	0.0
87	120.00	90.00	0.118391E-04	0.727830E-05	0.0
88	120.00	105.00	0.913261E-05	0.497273E-05	0.0
89	120.00	120.00	0.724816E-05	0.416852E-05	0.0
90	120.00	135.00	0.564819E-05	0.340545E-05	0.0
91	135.00	0.0	0.559424E-05	0.260722E-05	0.0
92	135.00	15.00	0.682870E-05	0.330471E-05	0.0
93	135.00	30.00	0.793094E-05	0.433685E-05	0.0
94	135.00	45.00	0.931167E-05	0.543708E-05	0.0
95	135.00	60.00	0.953792E-05	0.584229E-05	0.0
96	135.00	75.00	0.890261E-05	0.622636E-05	0.0
97	135.00	90.00	0.773651E-05	0.566565E-05	0.0
98	135.00	105.00	0.666418E-05	0.413564E-05	0.0
99	135.00	120.00	0.553240E-05	0.337909E-05	0.0
100	135.00	135.00	0.471120E-05	0.291369E-05	0.0
101	150.00	0.0	0.495862E-05	0.250728E-05	0.0
102	150.00	15.00	0.567185E-05	0.302633E-05	0.0
103	150.00	30.00	0.625953E-05	0.362632E-05	0.0
104	150.00	45.00	0.683158E-05	0.410527E-05	0.0
105	150.00	60.00	0.664626E-05	0.425627E-05	0.0
106	150.00	75.00	0.623051E-05	0.426139E-05	0.0
107	150.00	90.00	0.556220E-05	0.362056E-05	0.0
108	150.00	105.00	0.500286E-05	0.312878E-05	0.0
109	150.00	120.00	0.437397E-05	0.267063E-05	0.0
110	150.00	135.00	0.384447E-05	0.239179E-05	0.0
111	165.00	0.0	0.428689E-05	0.233240E-05	0.0
112	165.00	15.00	0.478360E-05	0.272467E-05	0.0
113	165.00	30.00	0.507485E-05	0.304037E-05	0.0
114	165.00	45.00	0.527171E-05	0.326085E-05	0.0
115	165.00	60.00	0.503937E-05	0.320271E-05	0.0
116	165.00	75.00	0.467766E-05	0.308850E-05	0.0
117	165.00	90.00	0.431703E-05	0.270235E-05	0.0
118	165.00	105.00	0.395329E-05	0.244097E-05	0.0
119	165.00	120.00	0.359300E-05	0.222828E-05	0.0
120	165.00	135.00	0.320430E-05	0.201768E-05	0.0

GROUND LEVEL CONCENTRATIONS

STRATEGY 4 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
121	74.55	68.50	0.500511E-04	0.238442E-04	0.0
122	79.55	69.90	0.744819E-04	0.492887E-04	0.0
123	82.05	53.40	0.452103E-04	0.303490E-04	0.0
124	82.55	79.30	0.576408E-04	0.303957E-04	0.0
125	83.05	69.50	0.970373E-04	0.686864E-04	0.0
126	83.55	58.00	0.563097E-04	0.431837E-04	0.0
127	89.25	63.50	0.830499E-04	0.101618E-03	0.0
128	91.85	72.50	0.952349E-04	0.635109E-04	0.0
129	98.45	68.00	0.516215E-04	0.275844E-04	0.0
130	94.55	68.00	0.711434E-04	0.460029E-04	0.0
131	101.25	94.00	0.231357E-04	0.807229E-05	0.0
132	105.05	64.60	0.304061E-04	0.175659E-04	0.0

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT PART G/CU M.
ANNUAL

AVERAGING TIME 1. HRS. HAS STANDARD DEVIATION = 2.10

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	2.077076E-05	1.576290E-05	2.678614E-04	1.565443E-04	8.976786E-05	4.084333E-05
56	4.701437E-05	3.567917E-05	6.063019E-04	3.543363E-04	2.009252E-04	9.244849E-05
66	9.356180E-05	7.100399E-05	1.206582E-03	7.051539E-04	3.998550E-04	1.839788E-04
76	2.891764E-05	2.194557E-05	3.729246E-04	2.179455E-04	1.235852E-04	5.686328E-05
86	1.404009E-05	1.065501E-05	1.810624E-04	1.058169E-04	6.000311E-05	2.760826E-05
121	5.005114E-05	3.798377E-05	6.454643E-04	3.772238E-04	2.139035E-04	9.841996E-05
122	7.448188E-05	5.652425E-05	9.605258E-04	5.613528E-04	3.183130E-04	1.464603E-04
123	4.521028E-05	3.431004E-05	5.830361E-04	3.407393E-04	1.932151E-04	8.890092E-05
124	5.764085E-05	4.374360E-05	7.433419E-04	4.344257E-04	2.463395E-04	1.133443E-04
125	9.703728E-05	7.364152E-05	1.251402E-03	7.313476E-04	4.147079E-04	1.908129E-04
126	5.630971E-05	4.273340E-05	7.261755E-04	4.243932E-04	2.406508E-04	1.107267E-04
127	8.304992E-05	6.302653E-05	1.071020E-03	6.259282E-04	3.549303E-04	1.633084E-04

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT PART G/CU M.
ANNUAL

AVERAGING TIME 8. HRS. HAS STANDARD DEVIATION = 1.92

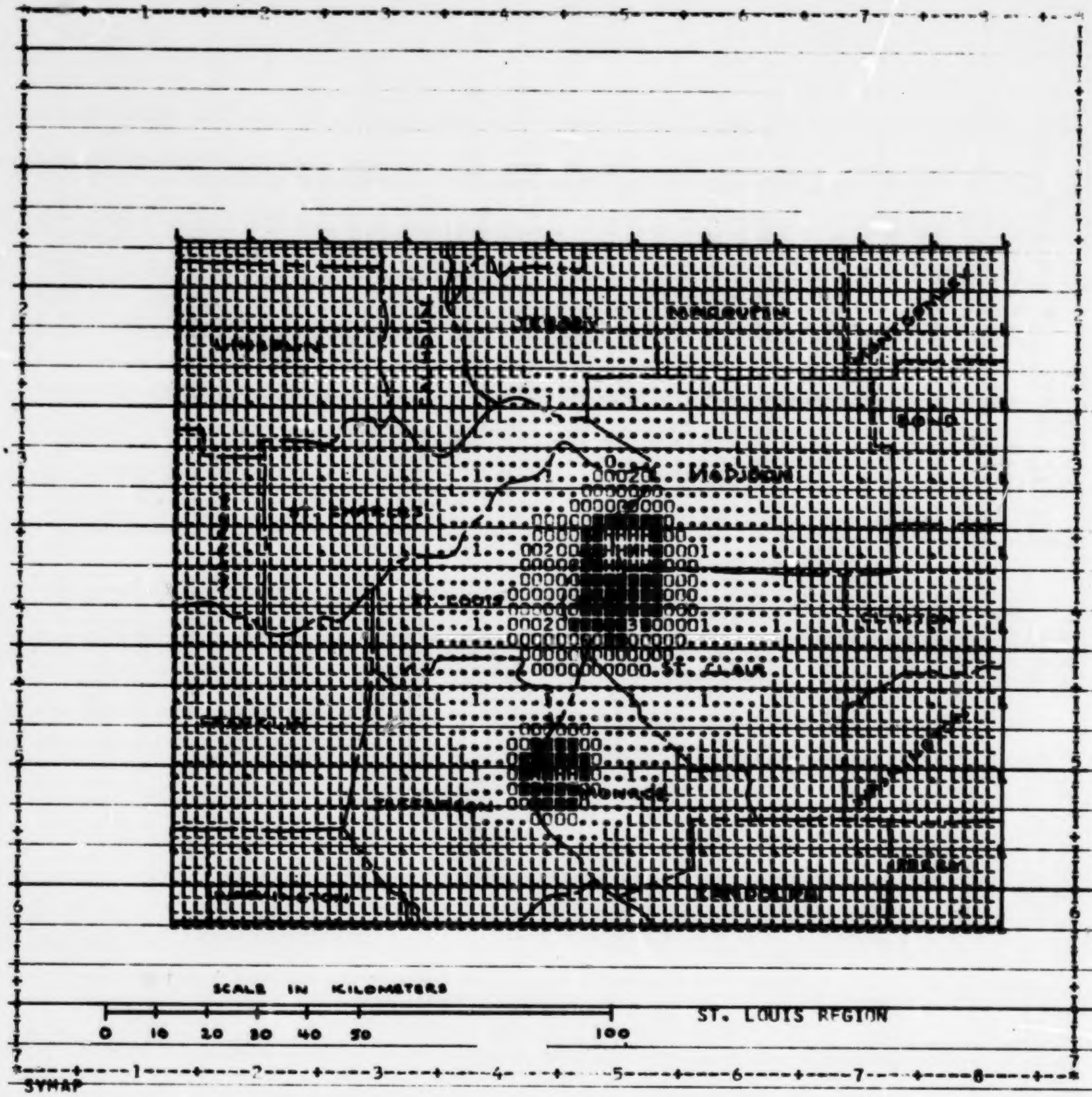
RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	2.077076E-05	1.679121E-05	1.412132E-04	1.260313E-04	7.658564E-05	3.873768E-05
56	4.701437E-05	3.800671E-05	3.196343E-04	2.852697E-04	1.733507E-04	8.768230E-05
66	9.356180E-05	7.563597E-05	6.360945E-04	5.677063E-04	3.449798E-04	1.744938E-04
76	2.891764E-05	2.337720E-05	1.966011E-04	1.754640E-04	1.066247E-04	5.393171E-05
86	1.404009E-05	1.135010E-05	9.545375E-05	8.519126E-05	5.176842E-05	2.618492E-05
121	5.005114E-05	4.046166E-05	3.402804E-04	3.036959E-04	1.845479E-04	9.334594E-05
122	7.448188E-05	6.021163E-05	5.063768E-04	4.519348E-04	2.746286E-04	1.389096E-04
123	4.521028E-05	3.654827E-05	3.073690E-04	2.743229E-04	1.666987E-04	8.431765E-05
124	5.764085E-05	4.659723E-05	3.918803E-04	3.497482E-04	2.125326E-04	1.075008E-04
125	9.703728E-05	7.844556E-05	6.597231E-04	5.887945E-04	3.577946E-04	1.809756E-04
126	5.630971E-05	4.552113E-05	3.828304E-04	3.416713E-04	2.076244E-04	1.050182E-04
127	8.304992E-05	6.713810E-05	5.646280E-04	5.039233E-04	3.062205E-04	1.548891E-04

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT PART G/CU M.
ANNUAL

AVERAGING TIME 24. HRS. HAS STANDARD DEVIATION = 1.82

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	2.077076E-05	1.736129E-05	1.009580E-04	1.104937E-04	6.993773E-05	3.740439E-05
56	4.701437E-05	3.929710E-05	2.285174E-04	2.501013E-04	1.583033E-04	8.466443E-05
66	9.356180E-05	7.820391E-05	4.547653E-04	4.977188E-04	3.150343E-04	1.684880E-04
76	2.891764E-05	2.417089E-05	1.405567E-04	1.538325E-04	9.736931E-05	5.207547E-05
86	1.404009E-05	1.173545E-05	6.824307E-05	7.468875E-05	4.727473E-05	2.528368E-05
121	5.005114E-05	4.183539E-05	2.432779E-04	2.662558E-04	1.685285E-04	9.013311E-05
122	7.448188E-05	6.225590E-05	3.620256E-04	3.962195E-04	2.507898E-04	1.341285E-04
123	4.521028E-05	3.778914E-05	2.197485E-04	2.405042E-04	1.522287E-04	8.141558E-05
124	5.764085E-05	4.817927E-05	2.801681E-04	3.066307E-04	1.940839E-04	1.038008E-04
125	9.703728E-05	8.110890E-05	4.716581E-04	5.162072E-04	3.267366E-04	1.747467E-04
126	5.630971E-05	4.706664E-05	2.736982E-04	2.995494E-04	1.896019E-04	1.014037E-04
127	8.304992E-05	6.941753E-05	4.036713E-04	4.417989E-04	2.796394E-04	1.495580E-04


1
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JERSEY
MACOUPIN
BOND
MADISON
ST. CHARLES
ST. LOUIS
ST. CLAIR
MONROE
CLINTON
JEFFERSON
RANDOLPH
SCALE IN KILOMETERS
0
10
20
30
40
50
100
ST. LOUIS REGION

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SYMAP
TIME =     C.0

C    PARTICULATE CONCENTRATION IN MICROGRAMS PER CUBIC METER
C    FOR THE ANNUAL SEASON .SING STRATEGY 4

DATA VALUE EXTREMES ARE          3.43       125.C8

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
                                                          ABOVE
  MINIMUM      BELOW      20.0C      5C.00      8C.00     110.00
  MAXIMUM      20.00      50.00      8C.00     110.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                          33.33      33.33      33.33

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL             L          1          2          3          H
                ==========================================================
                LLLLLLLLL  .........  000000000  █████████  HHHHHHHHH
                LLLLLLLLL  .........  000000000  █████████  HHHHHHHHH
  SYMBOLS       LLLLLLLLL  ....1....  000020000  ████3████  HHHHHHHHH
                LLLLLLLLL  .........  000000000  █████████  HHHHHHHHH
                LLLLLLLLL  .........  000000000  █████████  HHHHHHHHH
                ==========================================================
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SOX REDUCTION

REGIONAL COST = $52.132935 MILLIONS EFFECTIVENESS $36823.53 /TON

REGIONAL EMISSION = 271.20 TONS/DAY REGIONAL REDUCTION 83.97 %

SIC CODE	SITE NO.	DEVICE ID	NEW EMISSION TONS/DAY	DEVICE COST	DEVICE EFFICIENCY	REDUCTION TONS/DAY
2010	900	33	0.0	$ 135488.	100.00 %	0.230000E 01
2010	910	33	0.0	$ 291704.	100.00 %	0.905000E 01
2010	920	33	0.0	$ 285118.	100.00 %	0.608000E 01
2020	2000	33	0.0	$ 64259.	100.00 %	0.135000E 01
2046	2200	33	0.0	$ 700666.	100.00 %	0.187900E 02
2082	800	33	0.0	$ 74199.	100.00 %	0.158000E 01
2082	810	33	0.0	$ 788188.	100.00 %	0.179000E 02
2082	820	33	0.0	$ 110514.	100.00 %	0.317000E 01
2800	400	33	0.0	$ 422396.	100.00 %	0.102300E 02
2800	410	33	0.0	$ 1176921.	100.00 %	0.267400E 02
2800	420	33	0.0	$ 123855.	100.00 %	0.263000E 01
2800	430	33	0.0	$ 347850.	100.00 %	0.782000E 01
2819	330	33	0.0	$ 1270674.	100.00 %	0.316900E 02
2819	340	33	0.0	$ 961150.	100.00 %	0.203600E 02
2822	1900	33	0.0	$ 70014.	100.00 %	0.212000E 01
2841	2300	33	0.0	$ 112083.	100.00 %	0.238000E 01
2911	630	34	0.0	$ 54400.	100.00 %	0.870000E 00
3200	1400	33	0.0	$ 302053.	100.00 %	0.695000E 01
3210	1210	34	0.0	$ 348783.	100.00 %	0.293000E 01
3312	1100	33	0.0	$ 68824.	100.00 %	0.153000E 01
3312	1110	34	0.0	$ 381058.	100.00 %	0.602000E 01
3312	1113	1	0.804999E-01	$ 256332.	65.00 %	0.149500E 00
3323	700	33	0.0	$ 181111.	100.00 %	0.514000E 01
3323	710	34	0.0	$ 265165.	100.00 %	0.619000E 01
3332	2701	2	0.406000E 02	$ 123722.	80.00 %	0.162400E 03
3332	2702	2	0.264000E 00	$ 96671.	80.00 %	0.105600E 01
3332	2703	2	0.564000E 01	$ 22527.	80.00 %	0.225600E 02
3711	2500	33	0.0	$ 265021.	100.00 %	0.566000E 01
3711	2510	33	0.0	$ 224382.	100.00 %	0.474000E 01
3742	2400	33	0.0	$ 75507.	100.00 %	0.160000E 01
4911	10	33	0.0	$10137270.	100.00 %	0.248800E 03
4911	20	33	0.0	$ 5129903.	100.00 %	0.116950E 03
4911	30	33	0.0	$ 1574804.	100.00 %	0.390200E 02
4911	40	33	0.0	$ 1294228.	100.00 %	0.321400E 02
4911	50	33	0.0	$ 7759168.	100.00 %	0.192080E 03
4911	60	33	0.0	$ 153744.	100.00 %	0.359000E 01
4911	70	33	0.0	$15738280.	100.00 %	0.377200E 03
9900	200	33	0.0	$ 81169.	100.00 %	0.168000E 01
9900	210	33	0.0	$ 157200.	100.00 %	0.329000E 01
9900	220	33	0.0	$ 107020.	100.00 %	0.220000E 01
9900	230	33	0.0	$ 149398.	100.00 %	0.315000E 01
9900	240	33	0.0	$ 145736.	100.00 %	0.250000E 01
9900	250	32	0.252818E 00	$ 104532.	82.20 %	0.116718E 01

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                         GROUND LEVEL CONCENTRATIONS

STRATEGY 5 REDUCTION TO POLLUTANT SOX     PPM

AIR QUALITY STANDARD  0.181082E-01

| RECEPTOR |        LOCATION        | CONCENTRATION |   AMOUNT     | AMOUNT IN |
|          |     X      |     Y     |     VALUE     |   REDUCED    |  EXCESS   |
|     1    |    0.0     |    0.0    | 0.474548E-04  | 0.138581E-03 |  0.0      |
|     2    |    0.0     |   15.00   | 0.697348E-04  | 0.192123E-03 |  0.0      |
|     3    |    0.0     |   30.00   | 0.882191E-04  | 0.229539E-03 |  0.0      |
|     4    |    0.0     |   45.00   | 0.112878E-03  | 0.284889E-03 |  0.0      |
|     5    |    0.0     |   60.00   | 0.119393E-03  | 0.288472E-03 |  0.0      |
|     6    |    0.0     |   75.00   | 0.126911E-03  | 0.299815E-03 |  0.0      |
|     7    |    0.0     |   90.00   | 0.116390E-03  | 0.292718E-03 |  0.0      |
|     8    |    0.0     |  105.00   | 0.991778E-04  | 0.269982E-03 |  0.0      |
|     9    |    0.0     |  120.00   | 0.794000E-04  | 0.248821E-03 |  0.0      |
|    10    |    0.0     |  135.00   | 0.563072E-04  | 0.207130E-03 |  0.0      |
|    11    |   15.00    |    0.0    | 0.862561E-04  | 0.245554E-03 |  0.0      |
|    12    |   15.00    |   15.00   | 0.133271E-03  | 0.358557E-03 |  0.0      |
|    13    |   15.00    |   30.00   | 0.177611E-03  | 0.440603E-03 |  0.0      |
|    14    |   15.00    |   45.00   | 0.222601E-03  | 0.531840E-03 |  0.0      |
|    15    |   15.00    |   60.00   | 0.245305E-03  | 0.550520E-03 |  0.0      |
|    16    |   15.00    |   75.00   | 0.247390E-03  | 0.527201E-03 |  0.0      |
|    17    |   15.00    |   90.00   | 0.226904E-03  | 0.509402E-03 |  0.0      |
|    18    |   15.00    |  105.00   | 0.190206E-03  | 0.477409E-03 |  0.0      |
|    19    |   15.00    |  120.00   | 0.139849E-03  | 0.429207E-03 |  0.0      |
|    20    |   15.00    |  135.00   | 0.999378E-04  | 0.352761E-03 |  0.0      |
|    21    |   30.00    |    0.0    | 0.163999E-03  | 0.480099E-03 |  0.0      |
|    22    |   30.00    |   15.00   | 0.262874E-03  | 0.699228E-03 |  0.0      |
|    23    |   30.00    |   30.00   | 0.393629E-03  | 0.930113E-03 |  0.0      |
|    24    |   30.00    |   45.00   | 0.486492E-03  | 0.106616E-02 |  0.0      |
|    25    |   30.00    |   60.00   | 0.541078E-03  | 0.105132E-02 |  0.0      |
|    26    |   30.00    |   75.00   | 0.540469E-03  | 0.100273E-02 |  0.0      |
|    27    |   30.00    |   90.00   | 0.482386E-03  | 0.949035E-03 |  0.0      |
|    28    |   30.00    |  105.00   | 0.357375E-03  | 0.876401E-03 |  0.0      |
|    29    |   30.00    |  120.00   | 0.248617E-03  | 0.718749E-03 |  0.0      |
|    30    |   30.00    |  135.00   | 0.171443E-03  | 0.584539E-03 |  0.0      |
|    31    |   45.00    |    0.0    | 0.290134E-03  | 0.886690E-03 |  0.0      |
|    32    |   45.00    |   15.00   | 0.510659E-03  | 0.152364E-02 |  0.0      |
|    33    |   45.00    |   30.00   | 0.877870E-03  | 0.235256E-02 |  0.0      |
|    34    |   45.00    |   45.00   | 0.105134E-02  | 0.253771E-02 |  0.0      |
|    35    |   45.00    |   60.00   | 0.116306E-02  | 0.216029E-02 |  0.0      |
|    36    |   45.00    |   75.00   | 0.120280E-02  | 0.196366E-02 |  0.0      |
|    37    |   45.00    |   90.00   | 0.101809E-02  | 0.178173E-02 |  0.0      |
|    38    |   45.00    |  105.00   | 0.696008E-03  | 0.153539E-02 |  0.0      |
|    39    |   45.00    |  120.00   | 0.437699E-03  | 0.127452E-02 |  0.0      |
|    40    |   45.00    |  135.00   | 0.275597E-03  | 0.988994E-03 |  0.0      |
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GROUND LEVEL CONCENTRATIONS

STRATEGY 5 REDUCTION TO POLLUTANT SOX PPM

AIR QUALITY STANDARD 0.181082E-01

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
41	60.00	0.0	0.456446E-03	0.145643E-02	0.0
42	60.00	15.00	0.126774E-02	0.429090E-02	0.0
43	60.00	30.00	0.290771E-02	0.985417E-02	0.0
44	60.00	45.00	0.253479E-02	0.634363E-02	0.0
45	60.00	60.00	0.292292E-02	0.511252E-02	0.0
46	60.00	75.00	0.337388E-02	0.432803E-02	0.0
47	60.00	90.00	0.237117E-02	0.325158E-02	0.0
48	60.00	105.00	0.130860E-02	0.243998E-02	0.0
49	60.00	120.00	0.736191E-03	0.222801E-02	0.0
50	60.00	135.00	0.417619E-03	0.164144E-02	0.0
51	75.00	0.0	0.709709E-03	0.236833E-02	0.0
52	75.00	15.00	0.277836E-02	0.103372E-01	0.0
53	75.00	30.00	0.895061E-02	0.331939E-01	0.0
54	75.00	45.00	0.477491E-02	0.104562E-01	0.0
55	75.00	60.00	0.122086E-01	0.143612E-01	0.0
56	75.00	75.00	0.132613E-01	0.125592E-01	0.0
57	75.00	90.00	0.508412E-02	0.597909E-02	0.0
58	75.00	105.00	0.225916E-02	0.355990E-02	0.0
59	75.00	120.00	0.110719E-02	0.378661E-02	0.0
60	75.00	135.00	0.569846E-03	0.245097E-02	0.0
61	90.00	0.0	0.769818E-03	0.254372E-02	0.0
62	90.00	15.00	0.189588E-02	0.630176E-02	0.0
63	90.00	30.00	0.255939E-02	0.659313E-02	0.0
64	90.00	45.00	0.530319E-02	0.783900E-02	0.0
65	90.00	60.00	0.237407E-01	0.293137E-01	0.563248E-02
66	90.00	75.00	0.223022E-01	0.484853E-01	0.419402E-02
67	90.00	90.00	0.719044E-02	0.114863E-01	0.0
68	90.00	105.00	0.332280E-02	0.555995E-02	0.0
69	90.00	120.00	0.129285E-02	0.387078E-02	0.0
70	90.00	135.00	0.610909E-03	0.234392E-02	0.0
71	105.00	0.0	0.597754E-03	0.192239E-02	0.0
72	105.00	15.00	0.105953E-02	0.299141E-02	0.0
73	105.00	30.00	0.173355E-02	0.347187E-02	0.0
74	105.00	45.00	0.369000E-02	0.558215E-02	0.0
75	105.00	60.00	0.754025E-02	0.103422E-01	0.0
76	105.00	75.00	0.685732E-02	0.826982E-02	0.0
77	105.00	90.00	0.403525E-02	0.623477E-02	0.0
78	105.00	105.00	0.203792E-02	0.326072E-02	0.0
79	105.00	120.00	0.934853E-03	0.233973E-02	0.0
80	105.00	135.00	0.486703E-03	0.169879E-02	0.0

GROUND LEVEL CONCENTRATIONS

STRATEGY 5 REDUCTION TO POLLUTANT SOX PPM

AIR QUALITY STANDARD 0.181092E-01

RECEPTOR	LOCATION X	Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
81	120.00	0.0	0.441555E-03	0.133156E-02	0.0
82	120.00	15.00	0.736358E-03	0.186082E-02	0.0
83	120.00	30.00	0.124534E-02	0.238654E-02	0.0
84	120.00	45.00	0.206858E-02	0.338971E-02	0.0
85	120.00	60.00	0.256741E-02	0.418297E-02	0.0
86	120.00	75.00	0.216990E-02	0.411813E-02	0.0
87	120.00	90.00	0.160634E-02	0.347637E-02	0.0
88	120.00	105.00	0.993626E-03	0.214409E-02	0.0
89	120.00	120.00	0.559285E-03	0.155494E-02	0.0
90	120.00	135.00	0.309174E-03	0.104736E-02	0.0
91	135.00	0.0	0.330878E-03	0.953950E-03	0.0
92	135.00	15.00	0.517378E-03	0.126953E-02	0.0
93	135.00	30.00	0.785426E-03	0.160774E-02	0.0
94	135.00	45.00	0.105776E-02	0.203134E-02	0.0
95	135.00	60.00	0.110397E-02	0.226372E-02	0.0
96	135.00	75.00	0.928906E-03	0.234725E-02	0.0
97	135.00	90.00	0.744574E-03	0.202170E-02	0.0
98	135.00	105.00	0.521207E-03	0.136465E-02	0.0
99	135.00	120.00	0.328005E-03	0.984271E-03	0.0
100	135.00	135.00	0.208899E-03	0.710640E-03	0.0
101	150.00	0.0	0.237902E-03	0.687815E-03	0.0
102	150.00	15.00	0.344260E-03	0.872439E-03	0.0
103	150.00	30.00	0.453577E-03	0.104329E-02	0.0
104	150.00	45.00	0.539251E-03	0.122120E-02	0.0
105	150.00	60.00	0.513871E-03	0.128023E-02	0.0
106	150.00	75.00	0.446715E-03	0.124978E-02	0.0
107	150.00	90.00	0.358804E-03	0.101079E-02	0.0
108	150.00	105.00	0.273229E-03	0.788028E-03	0.0
109	150.00	120.00	0.192414E-03	0.593295E-03	0.0
110	150.00	135.00	0.129830E-03	0.450777E-03	0.0
111	165.00	0.0	0.164798E-03	0.498212E-03	0.0
112	165.00	15.00	0.216678E-03	0.604151E-03	0.0
113	165.00	30.00	0.264197E-03	0.677181E-03	0.0
114	165.00	45.00	0.286108E-03	0.749508E-03	0.0
115	165.00	60.00	0.263484E-03	0.739046E-03	0.0
116	165.00	75.00	0.230057E-03	0.692079E-03	0.0
117	165.00	90.00	0.190652E-03	0.568578E-03	0.0
118	165.00	105.00	0.151163E-03	0.458688E-03	0.0
119	165.00	120.00	0.114557E-03	0.372819E-03	0.0
120	165.00	135.00	0.793898E-04	0.287730E-03	0.0

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                         GROUND LEVEL CONCENTRATIONS

STRATEGY 5 REDUCTION TO POLLUTANT SOX    PPM

AIR QUALITY STANDARD  0.181082E-01

| RECEPTOR |        LOCATION         | CONCENTRATION |    AMOUNT     |  AMOUNT IN   |
|          |     X      |      Y     |     VALUE     |    REDUCED    |   EXCESS     |
|   121    |    74.55   |     68.50  | 0.157731E-01  | 0.140396E-01  | 0.0          |
|   122    |    79.55   |     69.90  | 0.266641E-01  | 0.281454E-01  | 0.855592E-02 |
|   123    |    82.05   |     53.40  | 0.156538E-01  | 0.198477E-01  | 0.0          |
|   124    |    82.55   |     79.30  | 0.153621E-01  | 0.207562E-01  | 0.0          |
|   125    |    83.05   |     69.50  | 0.409746E-01  | 0.413607E-01  | 0.228664E-01 |
|   126    |    83.55   |     58.00  | 0.247735E-01  | 0.301434E-01  | 0.666536E-02 |
|   127    |    89.25   |     63.50  | 0.658081E-01  | 0.479070E-01  | 0.476999E-01 |
|   128    |    91.85   |     72.50  | 0.234083E-01  | 0.457112E-01  | 0.530008E-02 |
|   129    |    98.45   |     68.00  | 0.229106E-01  | 0.165749E-01  | 0.480242E-02 |
|   130    |    94.55   |     68.00  | 0.219632E-01  | 0.267992E-01  | 0.385503E-02 |
|   131    |   101.25   |     94.00  | 0.478255E-02  | 0.599256E-02  | 0.0          |
|   132    |   105.05   |     64.60  | 0.850914E-02  | 0.936473E-02  | 0.0          |
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STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT SOX PPM
ANNUAL

AVERAGING TIME 1. HRS. STANDARD DEVIATION = 2.81

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	3.373881E-03	1.978521E-03	1.017427E-01	4.820013E-02	2.189584E-02	7.437855E-03
56	1.326133E-02	7.776745E-03	3.999084F-01	1.894547E-01	8.606339E-02	2.923512E-02
66	2.230221F-02	1.307853E-02	6.725453E-01	3.186150E-01	1.447370E-01	4.916612E-02
76	6.857324E-03	4.021291E-03	2.067893E-01	9.796542E-02	4.450269E-02	1.511724E-02
86	2.169900E-03	1.272479E-03	6.543547E-02	3.099975E-02	1.408223E-02	4.783630F-03
121	1.577313E-02	9.249724E-03	4.756544E-01	2.253389E-01	1.023645F-01	3.477250F-02
122	2.666410E-02	1.563645E-02	8.040829E-01	3.809303E-01	1.730449E-01	5.878212F-02
123	1.565382F-02	9.179763E-03	4.720567E-01	2.236345E-01	1.015903F-01	3.450949E-02
124	1.536209E-02	9.008680E-03	4.632590E-01	2.194667E-01	9.969693E-02	3.386634F-02
125	4.097460E-02	2.402845E-02	1.235630E 00	5.853738E-01	2.659173E-01	9.033012E-02
126	2.477355E-02	1.452778E-02	7.470711E-01	3.539213E-01	1.607755E-01	5.461429E-02
127	6.580812E-02	3.859140E-02	1.984509E 00	9.401519E-01	4.270821E-01	1.450767E-01

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT SOX · PPM
ANNUAL

AVERAGING TIME 8. HRS. STANDARD DEVIATION = 2.48

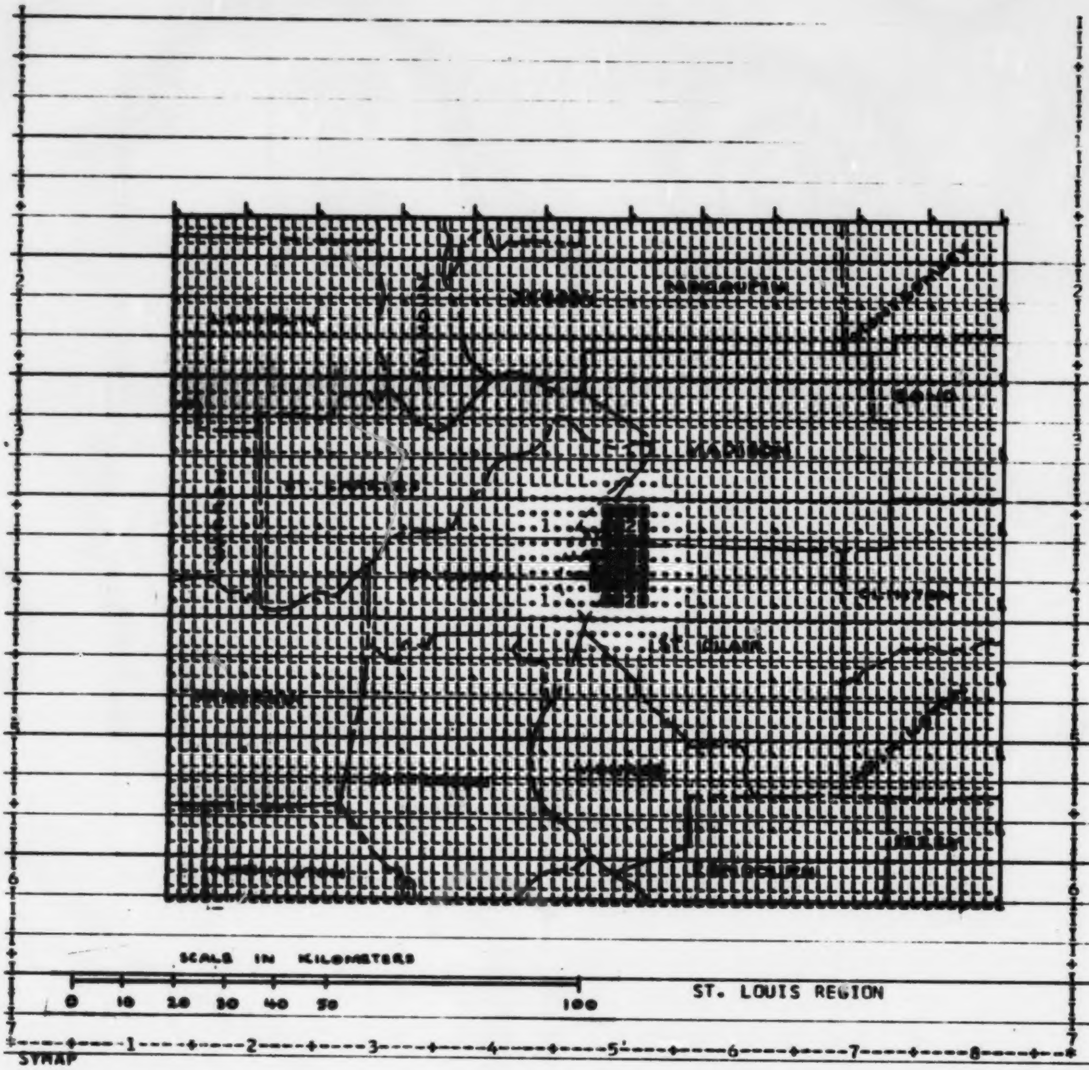
RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	3.373881E-03	2.235813E-03	4.322267E-02	3.689822E-02	1.845510E-02	7.151484E-03
56	1.326133E-02	8.788053E-03	1.698903E-01	1.450315E-01	7.253933E-02	2.810951E-02
66	2.230221E-02	1.477929E-02	2.857128E-01	2.439066E-01	1.219929E-01	4.727312E-02
76	6.857324E-03	4.544232E-03	8.784890E-02	7.499462E-02	3.750951E-02	1.453520E-02
86	2.169900E-03	1.437956E-03	2.779851E-02	2.373096E-02	1.186933E-02	4.599452E-03
121	1.577313E-02	1.045258E-02	2.020690E-01	1.725017E-01	8.627886E-02	3.343369E-02
122	2.666410E-02	1.766985E-02	3.415930E-01	2.916102E-01	1.458524E-01	5.651888E-02
123	1.565382E-02	1.037352E-02	2.005406E-01	1.711969E-01	8.562624E-02	3.318080E-02
124	1.536209E-02	1.018019E-02	1.968031E-01	1.680064E-01	8.403045E-02	3.256241E-02
125	4.097460E-02	2.715317E-02	5.249242E-01	4.481159E-01	2.241307E-01	8.685225E-02
126	2.477355E-02	1.641701E-02	3.173731E-01	2.709342E-01	1.355111E-01	5.251153E-02
127	6.580812E-02	4.360992E-02	8.430657E-01	7.197061E-01	3.599699E-01	1.394909E-01

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT SOX PPM
ANNUAL

AVERAGING TIME 24. HRS. STANDARD DEVIATION = 2.30

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	3.373881E-03	2.384990E-03	2.759916E-02	3.129062E-02	1.656337E-02	6.936219E-03
56	1.326133E-02	9.374406E-03	1.084808E-01	1.229904E-01	6.510371E-02	2.726340E-02
66	2.230221E-02	1.576539E-02	1.824374E-01	2.068389E-01	1.094881E-01	4.585017E-02
76	6.857324E-03	4.847430E-03	5.609456E-02	6.359732E-02	3.366461E-02	1.409768E-02
86	2.169900E-03	1.533898E-03	1.775030E-02	2.012445E-02	1.065267E-02	4.461005E-03
121	1.577313E-02	1.115000E-02	1.290280E-01	1.462858E-01	7.743490E-02	3.242731E-02
122	2.666410E-02	1.884881E-02	2.181188E-01	2.472928E-01	1.309019E-01	5.481761E-02
123	1.565382E-02	1.106566E-02	1.280520E-01	1.451793E-01	7.684916E-02	3.218203E-02
124	1.536209E-02	1.085943E-02	1.256655E-01	1.424736E-01	7.541698E-02	3.158227E-02
125	4.097460E-02	2.896487E-02	3.351821E-01	3.800135E-01	2.011563E-01	8.423793E-02
126	2.477355E-02	1.751237E-02	2.026535E-01	2.297590E-01	1.216206E-01	5.093089E-02
127	6.580812E-02	4.651964E-02	5.383263E-01	6.103288E-01	3.230714E-01	1.352921E-01


JERSEY
MACOUPIN
BOND
MADISON
ST. CHARLES
CLINTON
ST. CLAIR
1
2
SCALE IN KILOMETERS
0
10
20
30
40
50
100
ST. LOUIS REGION
1
2
3
4
5
6
7
8

```
SYMAP
TIME =    0.0

C    SO2 CONCENTRATION IN PARTS PER MILLION FOR THE ANNUAL SEASON
C    WITH STRATEGY 5

DATA VALUE EXTREMES ARE           0.00         0.02

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       BELOW        0.01        0.02
  MAXIMUM        0.01        0.02        0.03

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                             50.00       50.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL               L            1            2
               ==================================
               LLLLLLLLL  .........  
               LLLLLLLLL  .........  
  SYMBOLS      LLLLLLLLL  ....1....  
               LLLLLLLLL  .........  
               LLLLLLLLL  .........  
               ==================================
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Strategy 5 MAXIMUM CONTROL TECHNOLOGY STRATEGY SOURCE DATA

PART REDUCTION

REGIONAL COST = $53.671799 MILLIONS   EFFECTIVENESS $117,949.63 /TON

REGIONAL EMISSION = 108.20 TONS/DAY   REGIONAL REDUCTION 80.78%

SIC CODE	SITE NO.	DEVICE ID	NEW EMISSION TONS/DAY	DEVICE COST	DEVICE EFFICIENCY	REDUCTION TONS/DAY
2010	900	33	0.780069E-02	$ 135488.	99.62 %	0.204220E 01
2010	910	33	0.246728E-01	$ 291704.	99.79 %	0.115353E 02
2010	920	33	0.168146E-01	$ 285118.	99.69 %	0.542318E 01
2020	2000	33	0.535791E-02	$ 64259.	99.69 %	0.172464E 01
2040	101	17	0.298003E-01	$ 36489.	99.00 %	0.295020E 01
2040	111	17	0.228002E-01	$ 32581.	99.00 %	0.225720E 01
2040	121	17	0.149002E-01	$ 16815.	99.00 %	0.147510E 01
2040	131	17	0.204002E-01	$ 31211.	99.00 %	0.201960E 01
2040	141	17	0.248003E-01	$ 33701.	99.00 %	0.245520E 01
2040	151	17	0.248003E-01	$ 33701.	99.00 %	0.245520E 01
2040	161	17	0.496005E-01	$ 47588.	99.00 %	0.491040E 01
2040	171	17	0.149002E-01	$ 14092.	99.00 %	0.147510E 01
2040	181	17	0.348004E-01	$ 39252.	99.00 %	0.344520E 01
2040	191	17	0.378004E-01	$ 40932.	99.00 %	0.374220E 01
2046	2200	33	0.306866E-01	$ 700666.	99.72 %	0.107693E 02
2082	800	33	0.621334E-02	$ 74199.	99.69 %	0.200378E 01
2082	810	33	0.689871E-02	$ 788188.	99.70 %	0.228310E 01
2082	820	33	0.925255E-02	$ 110514.	99.77 %	0.399075E 01
2800	400	33	0.781769E-02	$ 422396.	99.61 %	0.197218E 01
2800	410	33	0.185510E-01	$ 1176921.	99.64 %	0.510145E 01
2800	420	33	0.728064E-02	$ 123855.	99.69 %	0.235272E 01
2800	430	33	0.222824E-01	$ 347850.	99.63 %	0.596772E 01
2819	301	18	0.190000E 00	$ 32660.	90.00 %	0.171000E 01
2819	330	33	0.556577E-01	$ 1270674.	99.71 %	0.192043E 02
2819	340	33	0.161530E-01	$ 961150.	99.59 %	0.388385E 01
2819	1601	1	0.438000E 00	$ 123058.	98.00 %	0.214620E 02
2819	1602	1	0.970002E 00	$ 109596.	98.00 %	0.475300E 02
2819	2601	17	0.800009E-01	$ 69372.	99.00 %	0.792000E 01
2822	1900	33	0.585377E-02	$ 70014.	99.86 %	0.425414E 01
2822	1901	17	0.145002E-01	$ 50293.	99.00 %	0.143550E 01
2841	2300	33	0.234706E-02	$ 112083.	99.69 %	0.757653E 00
2851	1701	17	0.240003E-01	$ 19182.	99.00 %	0.237600E 01
2911	630	34	0.864966E-02	$ 54400.	87.64 %	0.613503E-01
2951	1501	17	0.970010E-02	$ 6686.	99.00 %	0.960300E 00
3200	1400	33	0.263812E-01	$ 302053.	99.70 %	0.867362E 01
3210	1201	2	0.199501E 00	$ 34139.	94.30 %	0.330050E 01
3210	1210	34	0.708756E-01	$ 348783.	80.84 %	0.299124E 00
3241	1001	10	0.418500E 00	$ 150870.	85.00 %	0.237150E 01
3241	1011	10	0.870000E 00	$ 199865.	85.00 %	0.493000E 01
3250	2101	17	0.304003E-01	$ 44521.	99.00 %	0.300960E 01
3295	501	17	0.120001E-01	$ 18242.	99.00 %	0.118800E 01

MAXIMUM CONTROL TECHNOLOGY STRATEGY SOURCE DATA

PART REDUCTION

SIC CODE	SITE NO.	DEVICE ID	NEW EMISSION TONS/DAY	DEVICE COST	DEVICE EFFICIENCY	REDUCTION TONS/DAY
3295	511	17	0.191802E 00	$ 43676.	99.00 %	0.189882E 02
3295	521	17	0.822009E-01	$ 24670.	99.00 %	0.813780E 01
3295	531	17	0.137001E 00	$ 33948.	99.00 %	0.135630E 02
3312	1100	10	0.408001E-01	$ 26154.	98.00 %	0.199920E 01
3312	1110	34	0.610953E 00	$ 381058.	44.46 %	0.489046E 00
3312	1112	10	0.148000E 00	$ 277982.	80.00 %	0.592000E 00
3312	1113	16	0.270003E-02	$ 195014.	99.00 %	0.267300E 00
3312	1114	5	0.851999E 00	$ 38015.	70.00 %	0.198800E 01
3323	700	33	0.479399E-01	$ 181111.	99.31 %	0.685206E 01
3323	701	16	0.110001E-01	$ 66718.	99.00 %	0.108900E 01
3323	710	10	0.118000E-01	$ 73877.	98.00 %	0.578200E 00
3323	711	16	0.600006E-02	$ 59692.	99.00 %	0.594000E 00
3323	721	16	0.101001E-01	$ 14586.	99.00 %	0.999898E 00
3332	2701	2	0.248000E 00	$ 123722.	20.00 %	0.620000E-01
3332	2702	2	0.208000E 00	$ 96671.	20.00 %	0.520000E-01
3332	2703	2	0.160000E-01	$ 22527.	20.00 %	0.400000E-02
3711	2500	33	0.409509E-02	$ 265021.	99.62 %	0.107590E 01
3711	2510	33	0.187080E-01	$ 224382.	99.69 %	0.603129E 01
3742	2400	33	0.385876E-02	$ 75507.	99.68 %	0.121614E 01
4911	10	33	0.274517E 00	$10137270.	99.76 %	0.111825E 03
4911	20	33	0.414092E-01	$ 5129903.	99.73 %	0.152786E 02
4911	30	33	0.125153E-01	$ 1574804.	99.75 %	0.496748E 01
4911	40	33	0.104188E-01	$ 1294228.	99.74 %	0.404958E 01
4911	50	33	0.308489E-02	$ 7759168.	99.84 %	0.196691E 01
4911	60	33	0.118193E-01	$ 153744.	99.74 %	0.456818E 01
4911	70	33	0.314644E-01	$15738280.	99.74 %	0.120585E 02
4953	1301	10	0.765000E-01	$ 97289.	97.00 %	0.247350E 01
4953	1311	10	0.765000E-01	$ 97289.	97.00 %	0.247350E 01
9900	200	33	0.664151E-03	$ 81169.	99.68 %	0.209336E 00
9900	210	33	0.910850E-02	$ 157200.	99.69 %	0.293089E 01
9900	220	33	0.877972E-02	$ 107020.	99.69 %	0.283122E 01
9900	230	33	0.124267E-01	$ 149398.	99.69 %	0.400757E 01
9900	240	33	0.121118E-01	$ 145736.	99.62 %	0.317789E 01

GROUND LEVEL CONCENTRATIONS

STRATEGY 5 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
1	0.0	0.0	0.767446E-06	0.298975E-05	0.0
2	0.0	15.00	0.885413E-06	0.332241E-05	0.0
3	0.0	30.00	0.983310E-06	0.344747E-05	0.0
4	0.0	45.00	0.108109E-05	0.393884E-05	0.0
5	0.0	60.00	0.115471E-05	0.411785E-05	0.0
6	0.0	75.00	0.129420E-05	0.448522E-05	0.0
7	0.0	90.00	0.144640E-05	0.477918E-05	0.0
8	0.0	105.00	0.150862E-05	0.493961E-05	0.0
9	0.0	120.00	0.143053E-05	0.493176E-05	0.0
10	0.0	135.00	0.128271E-05	0.465198E-05	0.0
11	15.00	0.0	0.922076E-06	0.358417E-05	0.0
12	15.00	15.00	0.110153E-05	0.409785E-05	0.0
13	15.00	30.00	0.126368E-05	0.435530E-05	0.0
14	15.00	45.00	0.140883E-05	0.514374E-05	0.0
15	15.00	60.00	0.154346E-05	0.538392E-05	0.0
16	15.00	75.00	0.173253E-05	0.581715E-05	0.0
17	15.00	90.00	0.194789E-05	0.600140E-05	0.0
18	15.00	105.00	0.194996E-05	0.607603E-05	0.0
19	15.00	120.00	0.177836E-05	0.584106E-05	0.0
20	15.00	135.00	0.157338E-05	0.534302E-05	0.0
21	30.00	0.0	0.110338E-05	0.434681E-05	0.0
22	30.00	15.00	0.136176E-05	0.514694E-05	0.0
23	30.00	30.00	0.170116E-05	0.595939E-05	0.0
24	30.00	45.00	0.200226E-05	0.729652E-05	0.0
25	30.00	60.00	0.231443E-05	0.772644E-05	0.0
26	30.00	75.00	0.259064E-05	0.802195E-05	0.0
27	30.00	90.00	0.280795E-05	0.812267E-05	0.0
28	30.00	105.00	0.258975E-05	0.779620E-05	0.0
29	30.00	120.00	0.223822E-05	0.699027E-05	0.0
30	30.00	135.00	0.185419E-05	0.616063E-05	0.0
31	45.00	0.0	0.126964E-05	0.522591E-05	0.0
32	45.00	15.00	0.167215E-05	0.716032E-05	0.0
33	45.00	30.00	0.226938E-05	0.896238E-05	0.0
34	45.00	45.00	0.285997E-05	0.119603E-04	0.0
35	45.00	60.00	0.352722E-05	0.119879E-04	0.0
36	45.00	75.00	0.414729E-05	0.121094E-04	0.0
37	45.00	90.00	0.431498E-05	0.113656E-04	0.0
38	45.00	105.00	0.354642E-05	0.102408E-04	0.0
39	45.00	120.00	0.275339E-05	0.873751E-05	0.0
40	45.00	135.00	0.215553E-05	0.726626E-05	0.0

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                                        GROUND LEVEL CONCENTRATIONS

      STRATEGY 5 REDUCTION TO POLLUTANT PART  G/CU M.

      AIR QUALITY STANDARD  0.216967E-03

  | RECEPTOR |         LOCATION          | CONCENTRATION |    AMOUNT    |   AMOUNT IN   |
  |          |     X       |      Y      |     VALUE     |   REDUCED    |    EXCESS     |
  |    41    |    60.00    |      0.0    | 0.143713E-05  | 0.599256E-05 |  0.0          |
  |    42    |    60.00    |     15.00   | 0.205496E-05  | 0.104523E-04 |  0.0          |
  |    43    |    60.00    |     30.00   | 0.320865E-05  | 0.196526E-04 |  0.0          |
  |    44    |    60.00    |     45.00   | 0.460853E-05  | 0.236728E-04 |  0.0          |
  |    45    |    60.00    |     60.00   | 0.644780E-05  | 0.290947E-04 |  0.0          |
  |    46    |    60.00    |     75.00   | 0.827926E-05  | 0.210429E-04 |  0.0          |
  |    47    |    60.00    |     90.00   | 0.712515E-05  | 0.175664E-04 |  0.0          |
  |    48    |    60.00    |    105.00   | 0.493219E-05  | 0.143743E-04 |  0.0          |
  |    49    |    60.00    |    120.00   | 0.344892E-05  | 0.108930E-04 |  0.0          |
  |    50    |    60.00    |    135.00   | 0.250841E-05  | 0.843614E-05 |  0.0          |
  |    51    |    75.00    |      0.0    | 0.166805E-05  | 0.756016E-05 |  0.0          |
  |    52    |    75.00    |     15.00   | 0.255213E-05  | 0.150646E-04 |  0.0          |
  |    53    |    75.00    |     30.00   | 0.613053E-05  | 0.120269E-03 |  0.0          |
  |    54    |    75.00    |     45.00   | 0.709429E-05  | 0.359449E-04 |  0.0          |
  |    55    |    75.00    |     60.00   | 0.156948E-04  | 0.691282E-04 |  0.0          |
  |    56    |    75.00    |     75.00   | 0.233015E-04  | 0.445199E-04 |  0.0          |
  |    57    |    75.00    |     90.00   | 0.116305E-04  | 0.323125E-04 |  0.0          |
  |    58    |    75.00    |    105.00   | 0.659730E-05  | 0.205658E-04 |  0.0          |
  |    59    |    75.00    |    120.00   | 0.424281E-05  | 0.135845E-04 |  0.0          |
  |    60    |    75.00    |    135.00   | 0.295524E-05  | 0.103085E-04 |  0.0          |
  |    61    |    90.00    |      0.0    | 0.181027E-05  | 0.807231E-05 |  0.0          |
  |    62    |    90.00    |     15.00   | 0.271066E-05  | 0.135208E-04 |  0.0          |
  |    63    |    90.00    |     30.00   | 0.444160E-05  | 0.197401E-04 |  0.0          |
  |    64    |    90.00    |     45.00   | 0.913675E-05  | 0.278207E-04 |  0.0          |
  |    65    |    90.00    |     60.00   | 0.260491E-04  | 0.797298E-04 |  0.0          |
  |    66    |    90.00    |     75.00   | 0.347473E-04  | 0.132874E-03 |  0.0          |
  |    67    |    90.00    |     90.00   | 0.141995E-04  | 0.497669E-04 |  0.0          |
  |    68    |    90.00    |    105.00   | 0.799893E-05  | 0.235458E-04 |  0.0          |
  |    69    |    90.00    |    120.00   | 0.449225E-05  | 0.153643E-04 |  0.0          |
  |    70    |    90.00    |    135.00   | 0.299451E-05  | 0.111795E-04 |  0.0          |
  |    71    |   105.00    |      0.0    | 0.191672E-05  | 0.772575E-05 |  0.0          |
  |    72    |   105.00    |     15.00   | 0.278370E-05  | 0.109108E-04 |  0.0          |
  |    73    |   105.00    |     30.00   | 0.433135E-05  | 0.140688E-04 |  0.0          |
  |    74    |   105.00    |     45.00   | 0.762785E-05  | 0.213857E-04 |  0.0          |
  |    75    |   105.00    |     60.00   | 0.128887E-04  | 0.372398E-04 |  0.0          |
  |    76    |   105.00    |     75.00   | 0.125371E-04  | 0.307167E-04 |  0.0          |
  |    77    |   105.00    |     90.00   | 0.860639E-05  | 0.216636E-04 |  0.0          |
  |    78    |   105.00    |    105.00   | 0.555666E-05  | 0.141410E-04 |  0.0          |
  |    79    |   105.00    |    120.00   | 0.361721E-05  | 0.109096E-04 |  0.0          |
  |    80    |   105.00    |    135.00   | 0.261541E-05  | 0.898948E-05 |  0.0          |
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GROUND LEVEL CONCENTRATIONS

STRATEGY 5 REDUCTION TO POLLUTANT PART G/CU M.

AIR QUALITY STANDARD 0.216967E-03

RECEPTOR	LOCATION X	LOCATION Y	CONCENTRATION VALUE	AMOUNT REDUCED	AMOUNT IN EXCESS
81	120.00	0.0	0.186363E-05	0.710595E-05	0.0
82	120.00	15.00	0.259760E-05	0.913915E-05	0.0
83	120.00	30.00	0.377919E-05	0.114624E-04	0.0
84	120.00	45.00	0.538031E-05	0.153968E-04	0.0
85	120.00	60.00	0.636064E-05	0.176270E-04	0.0
86	120.00	75.00	0.577342E-05	0.166929E-04	0.0
87	120.00	90.00	0.482274E-05	0.142947E-04	0.0
88	120.00	105.00	0.359605E-05	0.105093E-04	0.0
89	120.00	120.00	0.270205E-05	0.871466E-05	0.0
90	120.00	135.00	0.204974E-05	0.700392E-05	0.0
91	135.00	0.0	0.176120E-05	0.644028E-05	0.0
92	135.00	15.00	0.230116E-05	0.783226E-05	0.0
93	135.00	30.00	0.298483E-05	0.928298E-05	0.0
94	135.00	45.00	0.363110E-05	0.111177E-04	0.0
95	135.00	60.00	0.380022E-05	0.115800E-04	0.0
96	135.00	75.00	0.343349E-05	0.116955E-04	0.0
97	135.00	90.00	0.303444E-05	0.103677E-04	0.0
98	135.00	105.00	0.253967E-05	0.826017E-05	0.0
99	135.00	120.00	0.202200E-05	0.688951E-05	0.0
100	135.00	135.00	0.168729E-05	0.593763E-05	0.0
101	150.00	0.0	0.159838E-05	0.586755E-05	0.0
102	150.00	15.00	0.195443E-05	0.674377E-05	0.0
103	150.00	30.00	0.233589E-05	0.754997E-05	0.0
104	150.00	45.00	0.256282E-05	0.837405E-05	0.0
105	150.00	60.00	0.250844E-05	0.839411E-05	0.0
106	150.00	75.00	0.230302E-05	0.818891E-05	0.0
107	150.00	90.00	0.208608E-05	0.709671E-05	0.0
108	150.00	105.00	0.183096E-05	0.630070E-05	0.0
109	150.00	120.00	0.160339E-05	0.544123E-05	0.0
110	150.00	135.00	0.135625E-05	0.488004E-05	0.0
111	165.00	0.0	0.138577E-05	0.523355E-05	0.0
112	165.00	15.00	0.162718E-05	0.588111E-05	0.0
113	165.00	30.00	0.184425E-05	0.627098E-05	0.0
114	165.00	45.00	0.190618E-05	0.662641E-05	0.0
115	165.00	60.00	0.183142E-05	0.641068E-05	0.0
116	165.00	75.00	0.168971E-05	0.607647E-05	0.0
117	165.00	90.00	0.157317E-05	0.544623E-05	0.0
118	165.00	105.00	0.141773E-05	0.497656E-05	0.0
119	165.00	120.00	0.128402E-05	0.453728E-05	0.0
120	165.00	135.00	0.112028E-05	0.410174E-05	0.0

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                         GROUND LEVEL CONCENTRATIONS

     STRATEGY 5 REDUCTION TO POLLUTANT PART  G/CU M.

     AIR QUALITY STANDARD  0.216967E-03

   | RECEPTOR |         LOCATION           | CONCENTRATION |    AMOUNT     |  AMOUNT IN   |
   |          |      X       |       Y     |     VALUE     |    REDUCED    |   EXCESS     |
   |   121    |    74.55     |     68.50   | 0.246181E-04  | 0.492776E-04  | 0.0          |
   |   122    |    79.55     |     69.90   | 0.379201E-04  | 0.858507E-04  | 0.0          |
   |   123    |    82.05     |     53.40   | 0.159204E-04  | 0.596394E-04  | 0.0          |
   |   124    |    82.55     |     79.30   | 0.277873E-04  | 0.602495E-04  | 0.0          |
   |   125    |    83.05     |     69.50   | 0.549883E-04  | 0.110736E-03  | 0.0          |
   |   126    |    83.55     |     58.00   | 0.268267E-04  | 0.726671E-04  | 0.0          |
   |   127    |    89.25     |     63.50   | 0.354729E-04  | 0.149195E-03  | 0.0          |
   |   128    |    91.85     |     72.50   | 0.411994E-04  | 0.117547E-03  | 0.0          |
   |   129    |    98.45     |     68.00   | 0.219504E-04  | 0.572558E-04  | 0.0          |
   |   130    |    94.55     |     68.00   | 0.306232E-04  | 0.865233E-04  | 0.0          |
   |   131    |   101.25     |     94.00   | 0.949855E-05  | 0.217097E-04  | 0.0          |
   |   132    |   105.05     |     64.60   | 0.138602E-04  | 0.341120E-04  | 0.0          |
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STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT PART G/CU M.
ANNUAL

AVERAGING TIME 1. HRS. STANDARD DEVIATION = 2.10

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	8.279258E-06	6.283124E-06	1.067702E-04	6.239887E-05	3.538305E-05	1.628023E-05
56	2.330147E-05	1.768347E-05	3.004980E-04	1.756179E-04	9.958349E-05	4.581973E-05
66	3.474730E-05	2.636970E-05	4.481045E-04	2.618823E-04	1.484995E-04	6.832667E-05
76	1.253711E-05	9.514408E-06	1.616799E-04	9.448935E-05	5.357985E-05	2.465282E-05
86	5.773422E-06	4.381447E-06	7.445464E-05	4.351296E-05	2.467386E-05	1.135279E-05
121	2.461807E-05	1.868262E-05	3.174767E-04	1.855406E-04	1.052101E-04	4.840863E-05
122	3.792011E-05	2.877753E-05	4.890212E-04	2.857950E-04	1.620591E-04	7.456561E-05
123	1.592038E-05	1.208197E-05	2.053108E-04	1.199883E-04	6.803891E-05	3.130564E-05
124	2.778728E-05	2.108773E-05	3.583471E-04	2.094262E-04	1.187544E-04	5.464054E-05
125	5.498834E-05	4.173061E-05	7.091351E-04	4.144344E-04	2.350036E-04	1.081284E-04
126	2.682667E-05	2.035874E-05	3.459593E-04	2.021865E-04	1.146491E-04	5.275164E-05
127	3.547294E-05	2.692037E-05	4.574622E-04	2.673513E-04	1.516006E-04	6.975351E-05

STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT PART G/CU M.
ANNUAL

AVERAGING TIME 8. HRS. STANDARD DEVIATION = 1.92

RECEPTOR	ARITHMETIC MEAN	GEOMETRIC MEAN	MAXIMUM CONCENTRATION	0.1% CONCENTRATION	1.0% CONCENTRATION	10.0% CONCENTRATION
46	8.279258E-06	6.693006E-06	5.628784E-05	5.023618E-05	3.052717E-05	1.544091E-05
56	2.330147E-05	1.883705E-05	1.584186E-04	1.413866E-04	8.591682E-05	4.345748E-05
66	3.474730E-05	2.808993E-05	2.362349E-04	2.108366E-04	1.281197E-04	6.480407E-05
76	1.253711E-05	1.013508E-05	8.523554E-05	7.607165E-05	4.622668E-05	2.338186E-05
86	5.773422E-06	4.667272E-06	3.925152E-05	3.503148E-05	2.128768E-05	1.076750E-05
121	2.461807E-05	1.990139E-05	1.673697E-04	1.493753E-04	9.077134E-05	4.591294E-05
122	3.792011E-05	3.065485E-05	2.578057E-04	2.300883E-04	1.398185E-04	7.072141E-05
123	1.592038E-05	1.287014E-05	1.082372E-04	9.660036E-05	5.870142E-05	2.969169E-05
124	2.778728E-05	2.246340E-05	1.889161E-04	1.686052E-04	1.024568E-04	5.182355E-05
125	5.498834E-05	4.445293E-05	3.738469E-04	3.336535E-04	2.027523E-04	1.025539E-04
126	2.682667E-05	2.168685E-05	1.823853E-04	1.627766E-04	9.891494E-05	5.003203E-05
127	3.547294E-05	2.867654E-05	2.411683E-04	2.152396E-04	1.307953E-04	6.615742E-05

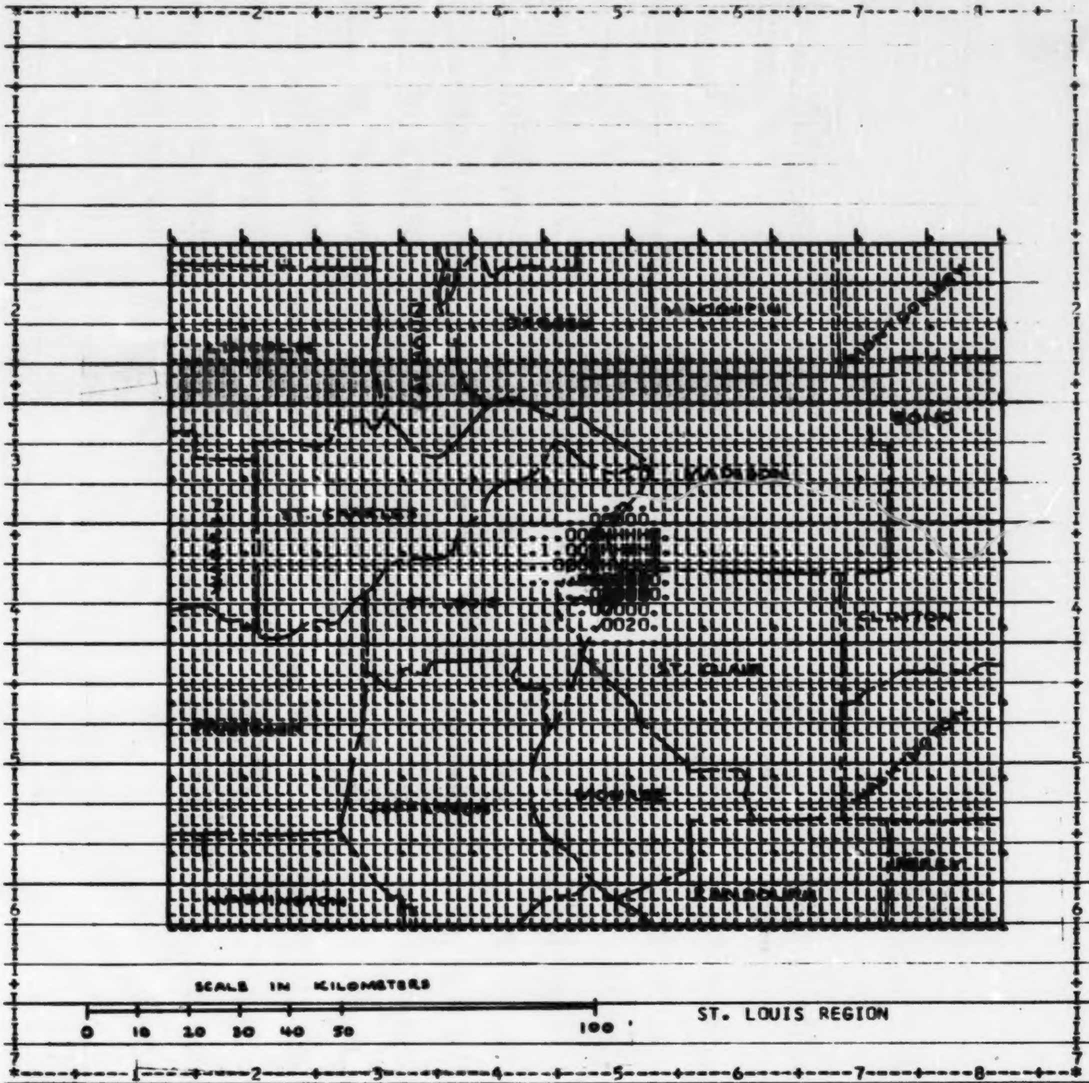
```
                              STATISTICAL DATA FOR SELECTED RECEPTORS

POLLUTANT  PART G/CU M.
ANNUAL


AVERAGING TIME  24. HRS.     STANDARD DEVIATION =  1.82

RECEPTOR  |  ARITHMETIC  |  GEOMETRIC  |     MAXIMUM     |      0.1%       |      1.0%       |      10.0%       |
          |     MEAN     |    MEAN     |  CONCENTRATION  |  CONCENTRATION  |  CONCENTRATION  |  CONCENTRATION   |
-----------------------------------------------------------------------------------------------------------------

   46     8.279258E-06   6.920242E-06   4.024206E-05     4.404299E-05      2.787729E-05      1.490946E-05
   56     2.330147E-05   1.947660E-05   1.132588E-04     1.239563E-04      7.845898E-05      4.196176E-05
   66     3.474730E-05   2.904363E-05   1.688923E-04     1.848445E-04      1.169985E-04      6.257363E-05
   76     1.253711E-05   1.047918E-05   6.093773E-05     6.669342E-05      4.221403E-05      2.257708E-05
   86     5.773422E-06   4.825733E-06   2.806222E-05     3.071275E-05      1.943983E-05      1.039690E-05
  121     2.461807E-05   2.057708E-05   1.196582E-04     1.309602E-04      8.289209E-05      4.433270E-05
  122     3.792011E-05   3.169563E-05   1.843140E-04     2.017228E-04      1.276817E-04      6.828729E-05
  123     1.592038E-05   1.330710E-05   7.738238E-05     8.469130E-05      5.360591E-05      2.866973E-05
  124     2.778728E-05   2.322606E-05   1.350624E-04     1.478193E-04      9.356320E-05      5.003986E-05
  125     5.498834E-05   4.596217E-05   2.672756E-04     2.925223E-04      1.851526E-04      9.902412E-05
  126     2.682667E-05   2.242315E-05   1.303934E-04     1.427093E-04      9.032874E-05      4.831000E-05
  127     3.547294E-05   2.965015E-05   1.724193E-04     1.887046E-04      1.194418E-04      6.388038E-05
```


MADISON
ST. CLAIR
SCALE IN KILOMETERS
0
10
20
30
40
50
100
ST. LOUIS REGION

```
 SYMAP
TIME =     0.0

C    PARTICULATE CONCENTRATTON IN MICROGRAMS PER CUBIC METER
C    FOR THE ANNUAL SEASON .SING STRATEGY 5

DATA VALUE EXTREMES ARE          0.77      34.75

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
                                                   ABOVE
  MINIMUM      BELOW      20.00      24.00     28.00      32.00
  MAXIMUM      20.00      24.00      28.00     32.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                          33.33      33.33     33.33

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          L           1           2           3           H
            ==================================================
            LLLLLLLLL  .........  000000000             HHHHHHHHH
            LLLLLLLLL  .........  000000000             HHHHHHHHH
  SYMBOLS   LLLLLLLLL  ....1....  000020000             HHHHHHHHH
            LLLLLLLLL  .........  000000000             HHHHHHHHH
            LLLLLLLLL  .........  000000000             HHHHHHHHH
            ==================================================
```

10

11

OPTIMAL CONTROL STRATEGY

```
     PDQ/LP RESULTS
     NAME      VALUE          STATUS      MIN VALUE        MAX VALUE      COST OF RND(DJ)    INPUT COST(CJ)
     ----   -------------    -------    -------------    -------------    ---------------    --------------
     COST  1127108.790893                                * * * * * OBJECTIVE * * * * *

****  SLACK VARIABLES

   1  R00001       63.938310   -SLACK       0.000000         NONE              NONE              NONE
   2  R00002       61.062765   -SLACK       0.000000         NONE              NONE              NONE
   3  R00003       58.790546   -SLACK       0.000000         NONE              NONE              NONE
   4  R00004       57.901559   -SLACK       0.000000         NONE              NONE              NONE
   5  R00005       60.159166   -SLACK       0.000000         NONE              NONE              NONE
   6  R00006       50.663665   -SLACK       0.000000         NONE              NONE              NONE
   7  R00007       42.397574   -SLACK       0.000000         NONE              NONE              NONE
   8  R00008       41.037105   -SLACK       0.000000         NONE              NONE              NONE
   9  R00009       39.079861   -SLACK       0.000000         NONE              NONE              NONE
  10  R00010       51.712505   -SLACK       0.000000         NONE              NONE              NONE
  11  R00011       51.501843   -SLACK       0.000000         NONE              NONE              NONE
  12  R00012       33.104179   -SLACK       0.000000         NONE              NONE              NONE
  13  R00013    0.             -SLACK       0.000000         NONE          131333.282805         NONE
  14  R00014        4.681857   -SLACK       0.000000         NONE              NONE              NONE
  15  R00015       29.266531   -SLACK       0.000000         NONE              NONE              NONE
  16  R00016       56.699603   -SLACK       0.000000         NONE              NONE              NONE
  17  R00017       40.741865   -SLACK       0.000000         NONE              NONE              NONE
  18  R00018         .647942   -SLACK       0.000000         NONE              NONE              NONE
  19  R00019       20.626465   -SLACK       0.000000         NONE              NONE              NONE
  20  R00020    0.             -SLACK       0.000000         NONE            1024.358657         NONE
  21  R00021       59.931071   -SLACK       0.000000         NONE              NONE              NONE
  22  R00022       51.165702   -SLACK       0.000000         NONE              NONE              NONE
  23  R00023       47.411230   -SLACK-      0.000000         NONE              NONE              NONE
  24  R00024       47.403487   -SLACK       0.000000         NONE              NONE              NONE
  25  R00025       52.921683   -SLACK       0.000000         NONE              NONE              NONE

****  STRUCTURAL VARIABLES
   1  S00001       19.080000   AT MAX       0.000000       19.080000      -8083.617033       157.200000
   2  S00002        8.180000   AT MAX       0.000000        8.180000      -8006.163223       333.000000
   3  S00003        7.900000   AT MAX       0.000000        7.900000     -11171.639575      9873.400000
   4  S00004        2.970000   AT MAX       0.000000        2.970000      -3082.634099      8686.800000
   5  S00005    0.             AT MIN       0.000000        4.570000      97178.774135    100656.000000
   6  S00006        2.270000   AT MAX       0.000000        2.270000     -25397.535451      9955.900000
   7  S00007       14.870000   AT MAX       0.000000       14.870000     -11489.470375     27168.700000
   8  S00008        2.030000   AT MAX       0.000000        2.030000     -41834.703628     10837.400000
   9  S00009        2.470000   AT MAX       0.000000        2.470000     *58046.952568      9757.000000
  10  S00010        2.470000   AT MAX       0.000000        2.470000     -38793.253422      9757.000000
  11  S00011        3.400000   AT MAX       0.000000        3.400000      -3572.864102     32647.000000
  12  S00012        4.940000   AT MAX       0.000000        4.940000     -97143.637784      8785.400000
  13  S00013        1.480000   AT MAX       0.000000        1.480000     -26907.535451      8445.900000
  14  S00014       10.923894   IN BDS       0.000000       21.500000          NONE           7441.800000
  15  S00015    0.             AT MIN       0.000000        1.960000     110006.820281    116326.000000
  16  S00016    0.             AT MIN       0.000000        3.460000       1460.836443      7803.400000
  17  S00017    0.             AT MIN       0.000000        2.030000      36476.555110     42857.100000
  18  S00018       36.915085   IN BDS       0.000000       95.000000          NONE           6505.300000
  19  S00019    0.             AT MIN       0.000000        1.880000      18902.264197     37234.000000
  20  S00020        4.010000   AT MAX       0.000000        4.010000     -57846.307914      2942.600000
  21  S00021       13.600000   AT MAX       0.000000       13.600000     -32332.593508       367.600000
  22  S00022    0.             AT MIN       0.000000        5.950000      19497.424935     25882.300000
  23  S00023       19.770000   AT MAX       0.000000       19.770000     -77231.638306       922.000000
```

```
                                        ECONOMETRIC MODEL
TO CALCULATE I(I) AT TIME T = 12 (1966), WE NEED AS AN INPUT VALUE K(I) AT TIME T-1 = 11 (1965).
   THESE VALUES, DENOTED BY THE NAME KTPRE, ARE
      CAPITAL STOCK OF INDUSTRY FOR THE YEAR T-1 ($MILLION)

      KTPRE( 1) =     274.829834          KTPRE( 2) =      91.699997          KTPRE( 3) =      78.869995
      KTPRE( 4) =     326.099854          KTPRE( 5) =     234.409988          KTPRE( 6) =     115.339996
      KTPRE( 7) =     343.389893          KTPRE( 8) =     113.119995          KTPRE( 9) =     108.899994
      KTPRE(10) =      62.399994          KTPRE(11) =     258.959961          KTPRE(12) =     165.909988


  ADDITIONAL REQUIRED INPUT, GIVEN AT TIME T = 12 (1966) IS:

      NATIONAL INCOME BY SECTOR I ($MILLION)
      YN( 1) =   15900.000000            YN( 2) =    6600.000000            YN( 3) =    9900.000000
      YN( 4) =   13700.000000            YN( 5) =    5700.000000            YN( 6) =    6100.000000
      YN( 7) =   16300.000000            YN( 8) =   12900.000000            YN( 9) =   21600.000000
      YN(10) =   17200.000000            YN(11) =   13800.000000            YN(12) =   52400.000000

      LOCAL TAX REVENUE ($MILLION)        NATIONAL UNEMPLOYMENT RATE (PERCENTAGE)
      CAPITAL T =     336.699951          UN =       3.799999

    CONTROL COST FOR INDUSTRY I
    THE COST OF CONTROL FOR EACH INDUSTRY (I) IS:                            STRATEGY I

      COC( 1) =        0.848000          COC( 2) =        0.0               COC( 3) =        0.0
      COC( 4) =        1.183000          COC( 5) =        0.054000          COC( 6) =        0.468000
      COC( 7) =        0.878000          COC( 8) =        0.0               COC( 9) =        0.0
      COC(10) =        0.0               COC(11) =        0.253000          COC(12) =        6.822000
```

```
FOR I = 12 (1966) WE HAVE THE FOLLOWING

  (A) VALUES COMPUTED WITHOUT THE COST CONTROL FACTOR

    EXPORT BY INDUSTRY I ($MILLION)            VALUE ADDED BY INDUSTRY I ($MILLION)
      E( 1) =      696.144775                     V( 1) =      444.836426
      E( 2) =       71.445984                     V( 2) =       81.662720
      E( 3) =      161.477951                     V( 3) =      184.569229
      E( 4) =      905.217529                     V( 4) =      500.585205
      E( 5) =      362.728760                     V( 5) =      200.588989
      E( 6) =      113.631573                     V( 6) =      149.994156
      E( 7) =      564.510742                     V( 7) =      388.383301
      E( 8) =      255.421951                     V( 8) =      248.270111
      E( 9) =      320.652832                     V( 9) =      250.429840
      E(10) =      234.704987                     V(10) =      166.171112
      E(11) =     1325.247803                     V(11) =     1072.125244
      E(12) =      396.998291                     V(12) =      376.751221

    IMPORT BY INDUSTRY I ($MILLION)      CAPITAL SHARE OF VALUE ADDED OR PROFIT BY INDUSTRY I ($MILLION)

      M( 1) =      294.036621                     PI( 1) =      244.660004
      M( 2) =       23.273865                     PI( 2) =       34.216675
      M( 3) =       52.602219                     PI( 3) =       70.690002
      M( 4) =      454.030518                     PI( 4) =      340.898438
      M( 5) =      181.934189                     PI( 5) =      137.202850
      M( 6) =       49.348068                     PI( 6) =       83.996704
      M( 7) =      234.971878                     PI( 7) =      163.120956
      M( 8) =       97.073593                     PI( 8) =      102.287262
      M( 9) =       85.646988                     PI( 9) =      105.931808
      M(10) =       91.061752                     PI(10) =       68.794830
      M(11) =     1680.019531                     PI(11) =      534.990234
```

```
     INVESTMENT OF INDUSTRY I ($MILLION)          CAPITAL STOCK OF INDUSTRY I ($MILLION)

           I( 1) =       21.997894                       K( 1) =      278.084717
           I( 2) =        7.319238                       K( 2) =       93.999725
           I( 3) =        0.086380                       K( 3) =       73.887695
           I( 4) =       34.872452                       K( 4) =      338.337402
           I( 5) =       35.615265                       K( 5) =      254.404816
           I( 6) =       14.358093                       K( 6) =      121.827988
           I( 7) =       56.809036                       K( 7) =      378.976074
           I( 8) =       12.825101                       K( 8) =      117.705719
           I( 9) =       14.098640                       K( 9) =      114.716141
           I(10) =        6.634609                       K(10) =       64.290039
           I(11) =       32.092422                       K(11) =      269.892578
           I(12) =       11.764499                       K(12) =      165.263214

                                                 ELECTRIC POWER DEMAND BY INDUSTRY I (1000 KILOWATT HOURS)
     EMPLOYMENT BY INDUSTRY I (1000)
           N( 1) =       27.340637                       Q( 1) =      324.317139
           N( 2) =        7.502899                       Q( 2) =       86.709137
           N( 3) =       16.015549                       Q( 3) =       63.629456
           N( 4) =       20.953110                       Q( 4) =      710.604004
           N( 5) =        7.562684                       Q( 5) =      426.775146
           N( 6) =        9.460421                       Q( 6) =      407.603516
           N( 7) =       28.658905                       Q( 7) =      479.152100
           N( 8) =       20.917435                       Q( 8) =      144.861633
           N( 9) =       20.022217                       Q( 9) =       51.447983
           N(10) =       15.445745                       Q(10) =      130.232010
           N(11) =       62.779495                       Q(11) =      575.497803
           N(12) =       50.492859                       Q(12) =       68.936401
```

```
LOCAL GOVERNMENT EXPENDITURE ($MILLION)        REGIONAL EXPENDITURE ($MILLION)                    CONSUMPTION ($MILLION)
     G =     347.718262                             Y* =     7007.703125                               C =     4436.082031

REGIONAL INCOME ($MILLION)                     EMPLOYMENT BY INDUSTRIES OTHER THAN                TOTAL EMPLOYMENT (1000)
                                                   MANUFACTURING INDUSTRIES (1000)
     Y =    7299.843750                             N-BAR =     650.430420                             N =     937.582275

TOTAL LABOR FORCE (1000)                       UNEMPLOYMENT (1000)                                LOCAL EMPLOYMENT RATE (PERCENT)
     L =     968.227539                             U =       30.645264                                SMALL U =       3.165089

ELECTRIC POWER DEMAND FOR RESIDENTIAL USE      ELECTRIC POWER DEMAND FOR NON-MANUFACTURING INDUSTRIES
     QC =    2659.126465                            Q-BAR =    1952.768799

WAGE PER MAN-YEAR BY INDUSTRY ($THOUSAND)
     W( 1) =        7.321568                        W( 2) =        6.323692                        W( 3) =        7.110534
     W( 4) =        7.621141                        W( 5) =        8.381430                        W( 6) =        6.976161
     W( 7) =        7.860111                        W( 8) =        6.978997                        W( 9) =        7.216878
     W(10) =        6.304406                        W(11) =        8.555889                        W(12) =        6.327327
```

```
(B) NEW VALUES COMPUTED WITH COST CONTROL FACTOR
   CAPITAL SHARE OF VALUE ADDED OR PROFIT BY INDUSTRY I          INVESTMENT OF INDUSTRY I ($MILLION)
                                       ($MILLION)
            PI*( 1) =     243.811996                              I*( 1) =      21.776566
            PI*( 2) =      34.216675                              I*( 2) =       7.319238
            PI*( 3) =      70.690002                              I*( 3) =       0.086380
            PI*( 4) =     339.715332                              I*( 4) =      34.742310
            PI*( 5) =     137.148849                              I*( 5) =      35.599548
            PI*( 6) =      83.528702                              I*( 6) =      14.335358
            PI*( 7) =     162.242950                              I*( 7) =      56.504379
            PI*( 8) =     102.287262                              I*( 8) =      12.825101
            PI*( 9) =     105.931808                              I*( 9) =      14.098640
            PI*(10) =      68.794830                              I*(10) =       6.634609
            PI*(11) =     534.737061                              I*(11) =      32.050385
            PI*(12) =      50.444153                              I*(12) =      11.331301
   CAPITAL STOCK OF INDUSTRY I ($MILLION)                       VALUE ADDED BY INDUSTRY I ($MILLION)
            K*( 1) =     277.877197                               V*( 1) =     444.504395
            K*( 2) =      93.999725                               V*( 2) =      81.662720
            K*( 3) =      73.887695                               V*( 3) =     184.569229
            K*( 4) =     338.215576                               V*( 4) =     500.404785
            K*( 5) =     254.390106                               V*( 5) =     200.577377
            K*( 6) =     121.806641                               V*( 6) =     149.967865
            K*( 7) =     378.687500                               V*( 7) =     388.087402
            K*( 8) =     117.705719                               V*( 8) =     248.270111
            K*( 9) =     114.716141                               V*( 9) =     250.429840
            K*(10) =      64.290039                               V*(10) =     166.171112
            K*(11) =     269.853760                               V*(11) =    1071.970947
            K*(12) =     164.860275                               V*(12) =     375.832520
```

```
EMPLOYMENT BY INDUSTRY I (1000)                    IMPORT BY INDUSTRY I ($MILLION)

     N*( 1) =       27.320221                          M*( 1) =      293.817383
     N*( 2) =        7.502899                          M*( 2) =       23.273865
     N*( 3) =       16.015549                          M*( 3) =       52.602219
     N*( 4) =       20.945557                          M*( 4) =      453.866943
     N*( 5) =        7.562247                          M*( 5) =      181.923660
     N*( 6) =        9.458763                          M*( 6) =       49.339417
     N*( 7) =       28.637085                          M*( 7) =      234.792862
     N*( 8) =       20.917435                          M*( 8) =       97.073593
     N*( 9) =       20.022217                          M*( 9) =       85.646988
     N*(10) =       15.445745                          M*(10) =       91.061752
     N*(11) =       62.770477                          M*(11) =     1679.777832
     N*(12) =       50.369736                          M*(12) =      188.292084

ELECTRIC POWER DEMAND BY INDUSTRY I (1000 KILOWATT HOURS)
     Q*( 1) =      324.118896
     Q*( 2) =       86.709137
     Q*( 3) =       63.629456
     Q*( 4) =      710.545410
     Q*( 5) =      426.771973
     Q*( 6) =      407.575928
     Q*( 7) =      478.760498
     Q*( 8) =      144.861633
     Q*( 9) =       51.447983
     Q*(10) =      130.232010
     Q*(11) =      575.432373
     Q*(12) =       68.736313
```

```
REGIONAL EXPENDITURE ($MILLION)             CONSUMPTION ($MILLION)                  REGIONAL INCOME ($MILLION)
  (Y*)* =   7007.976563                       C* =   4436.242188                      (Y)* =    7300.269531
EMPLOYMENT BY INDUSTRIES OTHER THAN
  MANUFACTURING INDUSTRIES (1000)           TOTAL EMPLOYMENT (1000)                 TOTAL LABOR FORCE (1000)
  N-BAR =     650.622803                      N* =    937.590576                      L* =     968.235352

UNEMPLOYMENT (1000)                         LOCAL EMPLOYMENT RATE (PERCENT)         ELECTRIC POWER DEMAND FOR RESIDENTIAL USE
  U* =      30.644775                         SMALL U* =      3.165012                QC* =   2659.278809
ELECTRIC POWER DEMAND FOR NON-MANUFACTURING
  INDUSTRIES
  Q-BAR* =    1953.836426
```

```
                                     ECONOMETRIC MODEL
 TO CALCULATE I(I) AT TIME T = 12 (1966), WE NEED AS AN INPUT VALUE K(I) AT TIME T-1 = 11 (1965).

   THESE VALUES, DENOTED BY THE NAME KTPRE, ARE
      CAPITAL STOCK OF INDUSTRY FOR THE YEAR T-1 ($MILLION)

      KTPRE( 1) =     274.829834          KTPRE( 2) =      91.699997          KTPRE( 3) =      78.869995
      KTPRE( 4) =     326.099854          KTPRE( 5) =     234.409988          KTPRE( 6) =     115.339996
      KTPRE( 7) =     343.389893          KTPRE( 8) =     113.119995          KTPRE( 9) =     108.899994
      KTPRE(10) =      62.399994          KTPRE(11) =     258.959961          KTPRE(12) =     165.909988


  ADDITIONAL REQUIRED INPUT, GIVEN AT TIME T = 12 (1966) IS:

      NATIONAL INCOME BY SECTOR I ($MILLION)
      YN( 1) =   15900.000000           YN( 2) =    6600.000000           YN( 3) =    9900.000000
      YN( 4) =   13700.000000           YN( 5) =    5700.000000           YN( 6) =    6100.000000
      YN( 7) =   16300.000000           YN( 8) =   12900.000000           YN( 9) =   21600.000000
      YN(10) =   17200.000000           YN(11) =   13800.000000           YN(12) =   52400.000000
      LOCAL TAX REVENUE ($MILLION)      NATIONAL UNEMPLOYMENT RATE (PERCENTAGE)
      CAPITAL T =      336.699951       UN =        3.799999

    CONTROL COST FOR INDUSTRY I
    THE COST OF CONTROL FOR EACH INDUSTRY (I) IS:

      COC( 1) =         0.326000          COC( 2) =         0.0               COC( 3) =         0.0
      COC( 4) =         0.266000          COC( 5) =         0.004000          COC( 6) =         0.344000
      COC( 7) =         0.275000          COC( 8) =         0.0               COC( 9) =         0.0
      COC(10) =         0.0               COC(11) =         0.0               COC(12) =         0.0
```

STRATEGY 3

```
(B) NEW VALUES COMPUTED WITH COST CONTROL FACTOR
CAPITAL SHARE OF VALUE ADDED OR PROFIT BY INDUSTRY I       INVESTMENT OF INDUSTRY I ($MILLION)
                                        ($MILLION)
          PI*( 1) =    244.334000                              I*( 1) =     21.912811
          PI*( 2) =     34.216675                              I*( 2) =      7.319238
          PI*(.3) =     70.690002                              I*( 3) =      0.086380
          PI*( 4) =    340.632324                              I*( 4) =     34.843170
          PI*( 5) =    137.198837                              I*( 5) =     35.614105
          PI*( 6) =     83.652695                              I*( 6) =     14.341370
          PI*( 7) =    162.845947                              I*( 7) =     56.713608
          PI*( 8) =    102.287262                              I*( 8) =     12.825101
          PI*( 9) =    105.931808                              I*( 9) =     14.098640
          PI*(10) =     68.794830                              I*(10) =      6.634609
          PI*(11) =    534.990234                              I*(11) =     32.092422
          PI*(12) =     57.266159                              I*(12) =     11.764499
CAPITAL STOCK OF INDUSTRY I ($MILLION)                      VALUE ADDED BY INDUSTRY I ($MILLION)

          K*( 1) =    278.004883                               V*( 1) =    444.708496
          K*( 2) =     93.999725                               V*( 2) =     81.662720
          K*( 3) =     73.887695                               V*( 3) =    184.569229
          K*( 4) =    338.310059                               V*( 4) =    500.544678
          K*( 5) =    254.403671                               V*( 5) =    200.588074
          K*( 6) =    121.812286                               V*( 6) =    149.974808
          K*( 7) =    378.885742                               V*( 7) =    358.290527
          K*( 8) =    117.705719                               V*( 8) =    248.270111
          K*( 9) =    114.716141                               V*( 9) =    250.429840
          K*(10) =     64.290039                               V*(10) =    166.171112
          K*(11) =    269.892578                               V*(11) =   1072.125244
          K*(12) =    165.263214                               V*(12) =    376.751221
```

```
      EMPLOYMENT BY INDUSTRY I (1000)                    IMPORT BY INDUSTRY I ($MILLION)

         N*( 1) =      27.332764                            M*( 1) =     293.952148
         N*( 2) =       7.502899                            M*( 2) =      23.273865
         N*( 3) =      16.015549                            M*( 3) =      52.602219
         N*( 4) =      20.951416                            M*( 4) =     453.993896
         N*( 5) =       7.562650                            M*( 5) =     181.933365
         N*( 6) =       9.459200                            M*( 6) =      49.341705
         N*( 7) =      28.652069                            M*( 7) =     234.915741
         N*( 8) =      20.917435                            M*( 8) =      97.073593
         N*( 9) =      20.022217                            M*( 9) =      85.646988
         N*(10) =      15.445745                            M*(10) =      91.061752
         N*(11) =      62.779495                            M*(11) =    1680.019531
         N*(12) =      50.492859                            M*(12) =     188.752350

      ELECTRIC POWER DEMAND BY INDUSTRY I (1000 KILOWATT HOURS)
         Q*( 1) =     324.240723
         Q*( 2) =      86.709137
         Q*( 3) =      63.629456
         Q*( 4) =     710.590820
         Q*( 5) =     426.774902
         Q*( 6) =     407.583252
         Q*( 7) =     479.029297
         Q*( 8) =     144.861633
         Q*( 9) =      51.447983
         Q*(10) =     130.232010
         Q*(11) =     575.497803
         Q*(12) =      68.536401
```

```
REGIONAL EXPENDITURE ($MILLION)              CONSUMPTION ($MILLION)             REGIONAL INCOME ($MILLION)
    (Y*)* =    7007.601563                     C  =     4436.019531                (Y)* =     7299.683594
EMPLOYMENT BY INDUSTRIES OTHER THAN
  MANUFACTURING INDUSTRIES (1000)            TOTAL EMPLOYMENT (1000)            TOTAL LABOR FORCE (1000)
    N-BAR* =    650.440186                     N* =     937.574463                 L* =     968.220215
UNEMPLOYMENT (1000)                          LOCAL EMPLOYMENT RATE (PERCENT)     ELECTRIC POWER DEMAND FOR RESIDENTIAL US
    U* =        30.645752                      SMALL U* =        3.165163          QC* =    2659.067871
ELECTRIC POWER DEMAND FOR NON-MANUFACTURING
  INDUSTRIES
    Q-BAR* =    1952.824219
```

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                                                  ECONOMETRIC MODEL
TO CALCULATE I(I) AT TIME T = 12 (1966), WE NEED AS AN INPUT VALUE K(I) AT TIME T-1 = 11 (1965).
    THESE VALUES, DENOTED BY THE NAME KTPRE, ARE
        CAPITAL STOCK OF INDUSTRY FOR THE YEAR T-1 ($MILLION)

        KTPRP( 1) =      274.829834          KTPRE( 2) =       91.699997          KTPRE( 3) =       78.869995
        KTPRE( 4) =      326.099854          KTPRE( 5) =      234.409988          KTPRE( 6) =      115.339996
        KTPRE( 7) =      343.389893          KTPRE( 8) =      113.11[illegible]95          KTPRE( 9) =      108.899994
        KTPRE(10) =       62.399994          KTPRE(11) =      258.959961          KTPRE(12) =      165.909988


ADDITIONAL REQUIRED INPUT, GIVEN AT TIME T = 12 (1966) IS:

        NATIONAL INCOME BY SECTOR I ($MILLION)
        YN( 1) =    15900.000000          YN( 2) =     6600.000000          YN( 3) =     9900.000000
        YN( 4) =    13700.000000          YN( 5) =     5700.000000          YN( 6) =     6100.000000
        YN( 7) =    16300.000000          YN( 8) =    12900.000000          YN( 9) =    21600.000000
        YN(10) =    17200.000000          YN(11) =    13800.000000          YN(12) =    52400.000000

        LOCAL TAX REVENUE ($MILLION)          NATIONAL UNEMPLOYMENT RATE (PERCENTAGE)
        CAPITAL T =      336.699951          UN =        3.799999

    CONTROL COST FOR INDUSTRY I
    THE COST OF CONTROL FOR EACH INDUSTRY (I) IS:

        COC( 1) =        0.441000          COC( 2) =        0.0          COC( 3) =        0.0
        COC( 4) =        0.035000          COC( 5) =        0.0          COC( 6) =        0.196000
        COC( 7) =        0.014000          COC( 8) =        0.0          COC( 9) =        0.0
        COC(10) =        0.0               COC(11) =        0.048000     COC(12) =        0.039000
```

STRATEGY 4

```
(B) NEW VALUES COMPUTED WITH COST CONTROL FACTOR
    CAPITAL SHARE OF VALUE ADDED OR PROFIT BY INDUSTRY I       INVESTMENT OF INDUSTRY I ($MILLION)
                                              ($MILLION)

          PI*( 1) =     244.218994                     I*( 1) =     21.882797

          PI*( 2) =      34.216675                     I*( 2) =      7.319238

          PI*( 3) =      70.690002                     I*( 3) =      0.086380

          PI*( 4) =     340.863281                     I*( 4) =     34.868576

          PI*( 5) =     137.202850                     I*( 5) =     35.615265

          PI*( 6) =      83.800705                     I*( 6) =     14.348572

          PI*( 7) =     163.106949                     I*( 7) =     56.804184

          PI*( 8) =     102.287262                     I*( 8) =     12.825101

          PI*( 9) =     105.931808                     I*( 9) =     14.098640

          PI*(10) =      68.794830                     I*(10) =      6.634609

          PI*(11) =     534.942139                     I*(11) =     32.084427

          PI*(12) =      57.227158                     I*(12) =     11.762022

    CAPITAL STOCK OF INDUSTRY I ($MILLION)             VALUE ADDED BY INDUSTRY I ($MILLION)

          K*( 1) =     277.976563                     V*( 1) =    444.663330

          K*( 2) =      93.999725                     V*( 2) =     81.662720

          K*( 3) =      73.887695                     V*( 3) =    184.569229

          K*( 4) =     338.333740                     V*( 4) =    500.579590

          K*( 5) =     254.404816                     V*( 5) =    200.588989

          K*( 6) =     121.819046                     V*( 6) =    149.983139

          K*( 7) =     378.971436                     V*( 7) =    388.378418

          K*( 8) =     117.705719                     V*( 8) =    248.270111

          K*( 9) =     114.716141                     V*( 9) =    250.429840

          K*(10) =      64.290039                     V*(10) =    166.171112

          K*(11) =     269.885254                     V*(11) =   1072.095947

          K*(12) =     165.260910                     V*(12) =    376.745850
```

```
EMPLOYMENT BY INDUSTRY I (1000)                  IMPORT BY INDUSTRY I ($MILLION)
    N*( 1) =       27.330002                         M*( 1) =      293.922363
    N*( 2) =        7.502899                         M*( 2) =       23.273865
    N*( 3) =       16.015549                         M*( 3) =       52.602219
    N*( 4) =       20.952866                         M*( 4) =      454.025635
    N*( 5) =        7.562684                         M*( 5) =      181.934189
    N*( 6) =        9.459725                         M*( 6) =       49.344452
    N*( 7) =       28.658554                         M*( 7) =      234.968918
    N*( 8) =       20.917435                         M*( 8) =       97.073593
    N*( 9) =       20.022217                         M*( 9) =       85.646988
    N*(10) =       15.445745                         M*(10) =       91.061752
    N*(11) =       62.777786                         M*(11) =     1679.973633
    N*(12) =       50.492157                         M*(12) =      188.749664

ELECTRIC POWER DEMAND BY INDUSTRY I (1000 KILOWATT HOURS)
    Q*( 1) =      324.213867
    Q*( 2) =       86.709137
    Q*( 3) =       63.629456
    Q*( 4) =      710.602051
    Q*( 5) =      426.775146
    Q*( 6) =      407.592041
    Q*( 7) =      479.145752
    Q*( 8) =      144.861633
    Q*( 9) =       51.447983
    Q*(10) =      130.232010
    Q*(11) =      575.485352
    Q*(12) =       68.935226
```

```
REGIONAL EXPENDITURE ($MILLION)                CONSUMPTION ($MILLION)                REGIONAL INCOME ($MILLION)
   (Y*)* =    7007.777344                         C* =    4436.125000                    (Y)* =    7299.960938
EMPLOYMENT BY INDUSTRIES OTHER THAN
  MANUFACTURING INDUSTRIES (1000)              TOTAL EMPLOYMENT (1000)               TOTAL LABOR FORCE (1000)
   N-BAR* =    650.458740                         N  =    937.596191                     L* =    968.240479

UNEMPLOYMENT (1000)                            LOCAL EMPLOYMENT RATE (PERCENT)       ELECTRIC POWER DEMAND FOR RESIDENTIAL USE
   U* =      30.644287                            SMALL U* =      3.164946              QC* =    2659.165527
ELECTRIC POWER DEMAND FOR NON-MANUFACTURING
  INDUSTRIES
   Q-BAR* =    1952.926758
```

```
                                                    ECONOMETRIC MODEL
TO CALCULATE I(I) AT TIME T = 12 (1966), WE NEED AS AN INPUT VALUE K(I) AT TIME T-1 = 11 (1965).
   THESE VALUES, DENOTED BY THE NAME KTPRE, ARE
      CAPITAL STOCK OF INDUSTRY FOR THE YEAR T-1 ($MILLION)

      KTPRE( 1) =     274.829834           KTPRE( 2) =      91.699997           KTPRE( 3) =      78.869995
      KTPRE( 4) =     326.099854           KTPRE( 5) =     234.409988           KTPRE( 6) =     115.339996
      KTPRE( 7) =     343.389893           KTPRE( 8) =     113.119995           KTPRE( 9) =     108.899994
      KTPRE(10) =      62.399994           KTPRE(11) =     258.959961           KTPRE(12) =     165.909988


  ADDITIONAL REQUIRED INPUT, GIVEN AT TIME T = 12 (1966) IS:

      NATIONAL INCOME BY SECTOR I ($MILLION)
      YN( 1) =   15900.000000              YN( 2) =    6600.000000            YN( 3) =    9900.000000
      YN( 4) =   13700.000000              YN( 5) =    5700.000000            YN( 6) =    6100.000000
      YN( 7) =   16300.000000              YN( 8) =   12900.000000            YN( 9) =   21600.000000
      YN(10) =   17200.000000              YN(11) =   13800.000000            YN(12) =   52400.000000

      LOCAL TAX REVENUE ($MILLION)         NATIONAL UNEMPLOYMENT RATE (PERCENTAGE)
      CAPITAL T =     336.699951           UN =        3.799999

   CONTROL COST FOR INDUSTRY I
   THE COST OF CONTROL FOR EACH INDUSTRY (I) IS:


      COC( 1) =        5.160999            COC( 2) =        0.0               COC( 3) =        0.0
      COC( 4) =        9.301999            COC( 5) =        0.115000          COC( 6) =        1.818000
      COC( 7) =        2.919999            COC( 8) =        0.0               COC( 9) =        0.0
      COC(10) =        0.0                 COC(11) =        1.101999          COC(12) =       84.819992
```

STRATEGY 5

```
(B) NEW VALUES COMPUTED WITH COST CONTROL FACTOR
   CAPITAL SHARE OF VALUE ADDED OR PROFIT BY INDUSTRY I        INVESTMENT OF INDUSTRY I ($MILLION)
                                          ($MILLION)
        PI*( 1) =      239.498993                          I*( 1) =      20.650879
        PI*( 2) =       34.216675                          I*( 2) =       7.319238
        PI*( 3) =       70.690002                          I*( 3) =       0.086380
        PI*( 4) =      331.596436                          I*( 4) =      33.849228
        PI*( 5) =      137.087845                          I*( 5) =      35.581802
        PI*( 6) =       82.178696                          I*( 6) =      14.269745
        PI*( 7) =      160.200943                          I*( 7) =      55.795792
        PI*( 8) =      102.287262                          I*( 8) =      12.825101
        PI*( 9) =      105.931808                          I*( 9) =      14.098640
        PI*(10) =       68.794830                          I*(10) =       6.634609
        PI*(11) =      533.888184                          I*(11) =      31.909470
        PI*(12) =      -27.553833                          I*(12) =       6.378432
   CAPITAL STOCK OF INDUSTRY I ($MILLION)                    VALUE ADDED BY INDUSTRY I ($MILLION)

        K*( 1) =      276.822754                           V*( 1) =     442.817627
        K*( 2) =       93.599725                           V*( 2) =      81.662720
        K*( 3) =       73.887695                           V*( 3) =     184.569229
        K*( 4) =      337.378418                           V*( 4) =     499.166260
        K*( 5) =      254.373306                           V*( 5) =     200.564133
        K*( 6) =      121.745010                           V*( 6) =     149.891983
        K*( 7) =      378.016602                           V*( 7) =     387.399902
        K*( 8) =      117.705719                           V*( 8) =     248.270111
        K*( 9) =      114.716141                           V*( 9) =     250.429840
        K*(10) =       64.290039                           V*(10) =     166.171112
        K*(11) =      269.723145                           V*(11) =    1071.451904
        K*(12) =      160.253372                           V*(12) =     365.330078
```

```
EMPLOYMENT BY INDUSTRY I (1000)                    IMPORT BY INDUSTRY I ($MILLION)
  N*( 1) =      27.216553                            M*( 1) =     292.702393
  N*( 2) =       7.502899                            M*( 2) =      23.273865
  N*( 3) =      16.015549                            M*( 3) =      52.602219
  N*( 4) =      20.893707                            M*( 4) =     452.743652
  N*( 5) =       7.961747                            M*( 5) =     181.911652
  N*( 6) =       9.453977                            M*( 6) =      49.314453
  N*( 7) =      28.586349                            M*( 7) =     234.376923
  N*( 8) =      20.917435                            M*( 8) =      97.073593
  N*( 9) =      20.022217                            M*( 9) =      85.646988
  N*(10) =      15.445745                            M*(10) =      91.061752
  N*(11) =      62.740097                            M*(11) =    1678.964355
  N*(12) =      48.962189                            M*(12) =     183.030350

ELECTRIC POWER DEMAND BY INDUSTRY I (1000 KILOWATT HOURS)
  Q*( 1) =     323.112061
  Q*( 2) =      86.709137
  Q*( 3) =      63.629456
  Q*( 4) =     710.142578
  Q*( 5) =     426.768555
  Q*( 6) =     407.496094
  Q*( 7) =     477.850342
  Q*( 8) =     144.861633
  Q*( 9) =      51.447983
  Q*(10) =     130.232010
  Q*(11) =     575.212646
  Q*(12) =      66.448868
```

```
REGIONAL EXPENDITURE ($MILLION)            CONSUMPTION ($MILLION)             REGIONAL INCOME ($MILLION)
  (Y*)* =    7010.093750                    C* =    4437.496094                 (Y)* =    7303.585938
EMPLOYMENT BY INDUSTRIES OTHER THAN
  MANUFACTURING INDUSTRIES (1000)          TOTAL EMPLOYMENT (1000)            TOTAL LABOR FORCE (1000)
  N-BAR* =     652.104904                   N* =     937.422363                 L* =     968.077393

UNEMPLOYMENT (1000)                        LOCAL EMPLOYMENT RATE (PERCENT)    ELECTRIC POWER DEMAND FOR RESIDENTIAL USE
  U* =       30.655029                      SMALL U* =        3.166588          QC* =    2660.466309
ELECTRIC POWER DEMAND FOR NON-MANUFACTURING
  INDUSTRIES
  Q-BAR* =    1962.048096
```